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ABSTRACT

This study describes and analyzes the nature of skill acquisition process in one indigenous, informal training system--the apprenticeship of the wayside mechanics workshops in Koforidua, Ghana. Chapter 2 places apprenticeships training in the wider context of artisanship and training. It traces the history of the West African craft shop and its apprenticeship and identifies and assesses the influence of factors internal and external to the small workshop. Chapter 3 describes the workshop in its urban context and its social organization of work. The apprenticeship agreement and the background of apprentices and masters are discussed. Case studies of master and apprenticeship mechanics are included. Chapter 4 analyzes data collected from observation, interviews, and observation instruments. Results of assessment of apprentice skill competence through self-reports and administration of a mechanics skill test are used to evaluate the effectiveness of training in fostering diagnostic skills and higher-order theoretical understanding. Chapter 5 discusses implications for building nonformal education programs around indigenous learning systems and considers supplementary skill training programs to upgrade skills of practicing artisans. Suggestions are given for designing such improvement programs, and a recently implemented program in Koforidua is described. (Assessment forms are appended.) (YLB)

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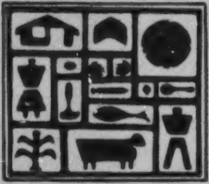

THE WAYSIDE MECHANIC: AN ANALYSIS OF SKILL ACQUISITION IN GHANA

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FOREWORD

Although nonformal education advocates have always included indigenous educational activities under their umbrella, relatively little serious work has been done in analyzing the examples of indigenous education schemes which exist today. The Wayside Mechanic is based on field work by the author in eastern Ghana, and focusses directly on the process of skill acquisition found in mechanics' workshops along the roadsides of Koforidua, the largest city in the region. Questions ranging from the level and extent of cognitive learning produced by the apprenticeship experience to the future viability of such small workshops are addressed in this work, which is part of a continuing series of book-length studies in nonformal education published by the Center for International Education.

While much of the research in nonformal education concentrates on training in pre-employment settings, this study looks at training which takes place during employment. Using an anthropological approach, the author visited a selected set of workshops, observed the patterns of daily activity, interviewed masters, journeymen, and apprentices, and used a set of specially created instruments to structure the observation of the learning/teaching interaction which occurred during the conduct of business in the workshops. The reader is presented with individual case studies of both masters and apprentices which provide insights into the problems and motivations of the individuals involved.

Using data generated by his instruments, the author undertakes an unusually creative process of analysis which provides structure to the otherwise undifferentiated flow of daily events in a wayside repair shop. The reader is drawn into the setting and begins to understand the constraints which operate on both the learners and their tutors. Analysis of both the process, and equally important, the opportunities for learning leads to a much clearer understanding of the kinds of learning which result.

The conclusions provide support for faith in the viability of this learning setting, while at the same time offering a much clearer understanding of the dynamics of the process. Understanding the limitations of the process in producing different kinds of learning raises questions about the kind of supplementary efforts which might be helpful in strengthening the system without at the same time undermining its basic viability.

Questions are raised about the capacity of the apprenticeship system and its future role in the development of servicing of motor vehicles in rural and relatively poor locations. The future of the small workshop, existing precariously on rented parcels of roadside land, appears to be an open question. Yet, the provision of formal training alternatives is at best only part of the answer. There remains a clear need for utilizing apprenticeship systems in some form. The extent to which such training functions as a substitute for cognitive development produced by formal schooling is also a subject addressed with some optimism by this work.

The publication of this study augments the small, but growing, number of detailed studies of apprenticeship learning schemes. While the results cannot be widely generalized, they do provide valuable insight into the process of learning in a functioning workshop. There are clear implications for both educators and policy makers, particularly in African settings. The reader will come away from the study with a feeling of what happens in a workshop, and with a much clearer understanding of the strength and limitations of the apprenticeship setting for producing various kinds of learning.

David R. Evans, Director
Center for International Education
January 1980

ABSTRACT

The Wayside Mechanic:
An Analysis of Skill Acquisition in Ghana

This is a study of skill learning in an informal learning setting in Africa. The purpose of the study is to describe and analyze the nature of the skill acquisition process in one indigenous training system: the apprenticeship of the wayside mechanics workshops in Koforidua, Ghana.

The study first examines informal skill training from a broad perspective. The history of the West African craft workshop and its associated apprenticeship is traced. Several major themes in the literature on informal skill training in Africa are then discussed as they apply to structured training systems such as apprenticeships.

The second part of the study describes the specific setting of the wayside mechanics workshops and the general features of the apprenticeship system. Subsequent sections consider contextual factors which may have a bearing on apprentice skill acquisition. Case studies of several apprentice and master artisans are presented to illustrate personal experiences at various levels of the mechanics profession.

Finally, the learning/teaching process in the wayside workshop is analyzed intensively using data gathered from general observation, structured interviews, and structured observation instruments.

Apprentice skill competence is assessed through self-reports and administration of a mechanics skill test. Results are used to evaluate the effectiveness of apprenticeship training in fostering diagnostic skills and higher-order theoretical understanding. Several possible ways of enhancing apprenticeship training through supplementary training programs are suggested.

The implications of the study are of interest to educational anthropologists who are concerned with learning in traditional, naturalistic settings. The study is also significant for educational planners in that it calls attention to the strengths and limitations of building nonformal educational programs around indigenous learning systems.

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To

My Mother and Father

CHAPTER I

INTRODUCTION

The Problem

Developing countries today are searching for the most effective ways to meet the immediate and future educational needs of their populations. The formal school has served an important educational function in these societies for many years and will continue to play a key role in their educational plans for the foreseeable future. But there is a growing realization among educational planners and development experts that formal education no longer can assume the full educational burden as it has in the past. The enormous expense of building new schools, training more teachers and purchasing equipment and materials has made further expansion of formal education more difficult. The persistent exclusion of many people from formal education and vocational training also has dramatized the need to find new ways to deliver education. Broad new expectations are being placed on the educational establishment just as the resources for meeting these expectations are dwindling.

As a result, educational planners are beginning to explore other less expensive, innovative modes of education to supplement the formal school system. One of their goals is to develop alternative forms of education for groups who frequently have been left out of the educational mainstream or who have special needs not easily handled by a formal approach. Included in this clientele would be such diverse groups as rural residents, artisans, market sellers and other small entrepreneurs, and unemployed youths, to name only a few. However, if truly appropriate education is to be offered to these groups, planners should take a serious look at the wide range of indigenous, out-of-school learning opportunities already present in their societies. By examining existing out-of-school education, they might learn how to design more effective educational and vocational training programs for people who have had little or no experience with formal education.

There is a vast assortment of settings in which such out-of-school education occurs in any society. Conventionally, these settings have been classified into three general categories: 1) incidental education, 2) informal education, and 3) nonformal education.[1] Incidental education has been associated predominantly, although not exclusively, with the child socialization process and is concerned with learning that takes place without any conscious intent either on the part of the learner or the source. Informal education, on the other hand, does involve a conscious intent to learn on the part of the learner, but with no similar attempt to structure or present the experience on the part of the source. Nonformal education refers to experiences that are fully intended to produce learning by both the learner and the source. This conscious intent, whenever present, implies the possibility of manipulating the learning outcome in some way and thus gives informal and nonformal education, in contrast to incidental education, their special relevance to alternative-seeking educational planners.

In Africa, out-of-school education includes everything from tribal "bush" schools and initiation ceremonies, to agricultural extension programs and literacy campaigns, to any number of informal training systems in specific trades and crafts. It is the latter indigenous skill training systems that serve as the general theme of this study.

Perhaps more than any other kind of out-of-school education, indigenous skill training systems provide their participants with real marketable skills at a time when even a secondary school certificate no longer guarantees a job in many places. In West Africa, these training systems have for generations quietly served local communities by engaging idle young people, including school leavers and drop-outs, in practical training which eventually provided many of them long-term jobs or self-employment. This training, which is conducted through apprenticeships of varying length, turns out the bulk of master craftsmen and artisans in such diverse trades as tailoring and seamstressing, carpentry, blacksmithing, automobile repair, cloth dyeing, weaving and basket-making among many others.

Yet comparatively little is known about indigenous training systems. For example, little is known about the individuals who become apprentices, their previous educational and employment backgrounds, and the means by which they are recruited into the workshops. Even fewer studies have been made about how the apprenticeships are organized and how they actually function as training systems within an ongoing business. There is little specific information about the kinds of specific skills that apprentices learn during their training or of the typical learning/teaching processes that are employed in the transfer of skills from masters to apprentices. Few of the cultural conditions surrounding these systems, including possible cultural barriers to learning technical skills, have been adequately explored. Finally, studies have only just begun to inquire into the cognitive and other psychological implications of indigenous skill training.

Purpose of the Study

This study examines one such indigenous skill training system--the wayside mechanics apprenticeships of Koforidua, Ghana. The study focuses on the apprenticeship's most important function as a training vehicle for aspiring young Ghanaian mechanics. The major purpose of the study is to describe the nature of the learning/teaching process in the wayside mechanics workshop: that is, (1) how are skills and knowledge transferred from masters to apprentices, and (2) what mechanical skills do apprentices learn and in what sequence, if any, do they learn them. This skill training process is then analyzed in terms of its potential to facilitate higher-level understanding of mechanical systems and diagnostic problem-solving abilities.

While the major theme of the study is an investigation of the skill learning process, several other related issues are discussed as well. A description is given of the social organization and day-to-day operation of typical wayside mechanics workshops to acquaint the reader with the overall setting in which training is conducted and to identify some of the real-life events that influence skill learning. Rather than using statistical data from which to draw conclusions, the description is personalized through the use of several case studies of apprentice and master mechanics who practice in Koforidua.

Some of the significant issues emanating from the few studies of informal skill training in Africa are raised to provide a framework for the examination of the specific conditions in the wayside mechanics workshops in Ghana. These include such issues as the evolution of apprenticeship training in West Africa, the relationship between the informal and formal sectors of the economy, the interface of informal skill training with formal and nonformal education, the factors affecting access to training, and the constraints under which training is conducted in the wayside workshop.

Finally, the educational implications of informal skill training are analyzed to identify any possible interventions that might be made to improve both the effectiveness of apprenticeship training and the general quality of workmanship in the profession as a whole. Some suggested supplementary skill-upgrading programs designed to operate concurrently with workshop training are described.

Cognitive Effects of Informal Education

One of the major objectives in the field of cognitive psychology and the ethnoscience branch of anthropology in recent years has been an attempt to isolate the crucial cultural and environmental variables that help to shape the cognitive capacities of people in different cultural milieus. Among the diverse variables suggested to have such effects are urbanization, industrialization, literacy, and formal education. Over the years a number of cross-cultural cognitive studies have pointed to exposure to formal schooling as a factor of considerable importance. Formal school students, in contrast to their non-schooled counterparts, have consistently demonstrated more generalized thinking and problem-solving skills over a wide variety of experimental tasks and test conditions.[2] Yet, however much it may facilitate the acquisition of higher cognitive skills, formal education still has serious limitations as an educational institution in the minds of many educational planners (as already noted).

A question of more than passing interest, then, is whether other educational settings might produce--or be modified to produce--some of the same cognitive outcomes as formal schooling. Indeed, there is some tantalizing evidence that certain kinds of out-of-school education may have just these effects. In a study involving indigenous tailors in Liberia, Lave uncovered problem-solving skills among experienced tailors that went beyond the solution of ordinary tailoring problems to include some kinds of unfamiliar non-tailoring problems.[3] Luria's extensive study of Russian rural peasants found substantial improvement in their abilities to reason deductively and solve problems as the result of their participation in the planning and management of a collective farm and their exposure to basic literacy.[4] Among the more descriptive accounts of cognitive processes in an informal, noninstitutional setting is Gladwin's study of traditional navigational training among the Pulawatan Islanders, in which complex, abstract navigational principles are taught to illiterate apprentice navigators by master navigators.[5] In the area of mathematics, Rosin dissected the elaborate mathematical system that an illiterate Indian man regularly used to solve complicated arithmetic problems in the marketplace.[6] His solution strategies, based on both culturally derived methods and personal inventions, allowed him to solve mathematical problems which were previously thought to go beyond the understanding of all but literate, school-educated individuals.

The extent to which these diverse learning experiences result in cognitive skills that transcend their limited areas of application is debatable. Of course, no one is yet prepared to claim that informal education, no matter how structured or rigorous, is a substitute for the de-contextualized symbolic learning systems of the formal school, which obviously have wide applications in various aspects of a modern society. But they do demonstrate that the educational contrivances of even illiterate, unschooled peoples frequently produce cognitive effects of impressive intellectual value.

It may be well worth considering the suggestion of Scribner and Cole who call for fundamental revisions in the social organization of education in developing societies.[7] To increase the likelihood that informal educational settings (such as apprenticeship training) might enhance the cognitive abilities of learners, they advocate the fusion of formal schooling with the learning experiences of everyday life. For example, informal learning might be made more systematic and rigorous by introducing the learning/teaching techniques of the formal school "into the context of recognized practical problems." As they put it, "Education must be stripped from the schoolrooms and made instrumental in traditional settings." This is a theme that will be taken up once again in the final chapter.

Limitations of the Study

One of the inherent differences between the formal school and an educational enterprise such as apprenticeship training is the high degree of formality and explicitness of school instruction. While the school can be described more or less accurately as age-graded cohorts that pass lock-step through specified time periods learning well-defined bodies of knowledge, apprenticeship skill training is more difficult to characterize. To understand how apprenticeship training functions as a learning system, it is necessary to classify and periodize the content of the training into identifiable levels of skill and knowledge that roughly reflect the competence of apprentices at different stages of training.

Accomplishing this with a reasonable degree of accuracy, however, runs headlong into methodological problems. For example, documenting what is really a rather extended training period must necessarily be encapsulated into a relatively short observational period. This leads to the possibility of distorted and incorrect inferences of reality. Moreover, the description of the skill learning experience in its totality is limited in the sense that it is composed of observations of a large but finite number of single instances. These observations may accurately capture the events of particular moments in time, but taken together, may only roughly approximate what is in fact a much more complex and dynamic process.

As stated earlier, this study addresses the issue of skill learning in an out-of-school context. It is not a rigorous experimental investigation of the cognitive performance of wayside mechanics in the classic psychological tradition. However, the study does represent an initial exploration into the question of cognition in informal learning settings and thus lays the basis for a more specific follow-up study of those effects.

The study is limited in another way. Although some of the factors affecting the operation of the wayside mechanics workshops and their apprenticeships are discussed at length, there are other influences that receive much less or no attention. Economic factors, for example, are important in determining not only the viability of the workshop as a business, but the quality of the training therein as well. While these economic issues are accounted for to some extent, the study does not deal with them extensively.

Design of the Study

The study was conducted over a fourteen month period beginning in June 1976 in the regional city of Koforidua, Ghana. There were several phases to the study. The first phase lasted about two months and consisted of a survey of all the wayside mechanics workshops in Koforidua. This survey was intended to locate all the wayside mechanics workshops in the community and collect some basic data about them, including: 1) the names of masters working the workshop sites; 2) their trades and specialities; 3) the size of the workshops (i.e., the number of apprentices and general volume of business they had); 4) how well equipped the workshops were; 5) what languages were spoken by masters; and 6) any unusual features of the workshops. The main purpose of this survey was to gain some idea of the size of the universe being studied. These initial data then became the basis for decisions on which workshops to return to for further observation and systematic data collection.

The next phase of the research was a period of unstructured observation of wayside mechanics workshops which lasted several months. These observations were conducted in a variety of workshops in Koforidua and were intended to familiarize the author with the general operation of the wayside workshops as well as to develop closer relationships with the artisans themselves. The beginnings of the effort to classify some of the typical mechanical jobs and skills involved and the division of labor used to accomplish them were made during this phase. Since wayside mechanics workshops usually contain several automotive-related craftsmen such as mechanics, auto-electricians, welders, body-builders or straighteners, sprayers, and blacksmiths, it was decided to focus the research only on those tradesmen who were concerned with the functioning of the engine and the other moving parts of the vehicles--that is, the mechanics and, to a much lesser extent, the auto-electricians.

After a few months of conducting the survey and doing unstructured observation, a concern arose about the rather amorphous nature of the data being gathered. Also, due to an increasing familiarity with the workshops, a number of more specific research questions were beginning to surface which required more specific data collection techniques. The third phase of the research, then, was the period of more systematic inquiry, which lasted for the final nine months of the field research.

Several different data collection instruments, which will be described shortly, were used to obtain specific kinds of information. The purpose of these methods was to supplement what was being learned through unstructured observation. They included a structured interview questionnaire, a workshop business activity report, an observation classification instrument and a motor mechanics skills test. It was decided during this phase to restrict the number of workshops for which more detailed data would be collected to a small sample. Six or seven workshops which seemed to be representative of all types of wayside mechanics workshops in Koforidua were selected for more intensive study.

Research Methods

As mentioned above, several data collection instruments were employed to answer specific research questions. Each of these instruments is now described.

Structured Interview Questionnaire. While unstructured observations were a rich source of information about the wayside workshops, there was a need to focus on several important issues that had begun to emerge. This required appropriate questions to elicit relevant answers in conversations with artisans. A structured interview questionnaire was assembled for this purpose, which can be found in Appendix A. In constructing the questionnaire, a list was compiled of conceptual categories representing factors that seemed important in analyzing the informal learning system. These categories are reflected in the following major question areas which the questionnaire incorporated:

1) the personal background of apprentices and masters
2) the educational, training, and work background of apprentices and masters
3) the nature of the instructional experience from the point of view of both apprentices (learners) and masters (teachers)
4) the nature of the work, the amount of work, and the way that work is distributed among workers
5) the organization of the content of the training (the instructional scope and sequence)
6) the technical skills of the masters and journeymen
7) the nature of the apprenticeship agreement
8) the future educational and employment plans of apprentices.

Separate versions of the questionnaire were drawn up for apprentices and masters that reflected the different levels of their experience and the different perspectives from which they view the profession. To assist in organizing the answers to the questions about the content of the training (question area no. five above), a grid was used to record the answers of each individual interviewed. Although the questionnaire was not field-tested on test samples of mechanics, the draft versions were circulated to several experienced mechanics whom the author knew for their suggestions and feedback concerning the data-worthiness and appropriateness of the questions. When question items were found to be offensive or redundant they were removed.

Observation Category System. One of the most important elements of informal skill training is the verbal interaction between apprentices, journeymen, and masters. Because of the significant role verbal interaction plays, it seemed advisable to record some of the workshop dialogue so that it could be analyzed in more detail at a later time. Therefore, a modified version of Flanders' Interaction Analysis was used to make a written record of the verbal interactions and activities in a few workshops. Basically, what was done was to take some of Flanders' categories that seemed relevant to this learning context and then add categories representing other workshop activities with instructional implications. These categories were then organized into a ten-digit coding system, the exact description of which can be found in Appendix D. Instead of observing an entire class and recording an observation every three seconds as called for with Flanders' original system, the observer focuses only on one individual at a time and makes an observation notation every minute or whenever a change of activity occurs. This procedure was arrived at after experimentation with a number of different procedures.

Two Ghanaian assistants were employed to actually conduct the observations. This was necessary because most of the verbal interaction in the workshops is conducted in one of the local languages. To make sure that the two observers were using the system correctly, their recording sheets were closely scrutinized after they returned from the observation sessions to find out how they had interpreted various behaviors and whether they had kept pace with the actual flow of events in the workshop. Also, to test inter-observer reliability, the two observers were sometimes sent out together to observe the same person over the same period of time and the results were compared. Generally, it was found that they differed on only one or two codings over an observation session of sixty minutes.

To provide a check on a research activity that was taking place primarily in a language that the author did not understand, the main observer of the workshop activities, a young secondary school student, who was also a part-time apprentice mechanic himself, was asked to conduct several observation sessions while tape-recording those same sessions. He was asked to synchronize the tape with his own notations so that it would be possible to analyze his use of the observation instrument after the dialogue had been translated and transcribed to a written sheet. In general, this observer's technical handling of the instrument as well as his interpretation of verbal statements as against the observation categories were reasonably accurate after a several week's period of practice.

Workshop Business Activity Report. One of the most important factors determining an apprentice's ability to learn his craft is his access to learning opportunities in the workshop. Access to learning opportunities is partly a function of the number of apprentices in the workshop who have to share these opportunities and also partly a function of the amount of business that the workshop has on a regular basis. To obtain an accurate picture of just how much business wayside workshops have, a business activity reporting scheme was developed for use in a sample of workshops. This scheme was essentially nothing more than a form which one of the older apprentices or the master filled out every day. The worker who was responsible for completing the form daily would keep track of all vehicles that entered the workshop for repairs every day as well as those vehicles that remained in the workshop because they were not yet completed. He would also note which apprentices worked on each vehicle and, whenever possible, exactly what each person actually did. That is, if several apprentices worked on a particular repair job, his record would distinguish the worker who did the main job and those who performed a support role. This information provided some idea of how much work there actually was in the sample workshops and who had the opportunities to do this work.

In theory the procedure was quite straightforward. In practice there was great difficulty in convincing the workers keeping the record to fill out the form regularly, accurately, and in enough detail to be useful. However, after an initial period of regularizing the recording of business activity, they were able to keep a fairly consistent record. The procedure was followed in a sample of six workshops for a three month period, about six weeks of which were suitable to use.

Mechanics Skill Testing. One of the major research goals of the study was, of course, to determine exactly what apprentices learn during their apprenticeship training. There are two ways to determine this: 1) indirectly, through a structured interview in which apprentices are asked to recall exactly what they learned at various stages of their training, and 2) directly, through either observation of on-the-job performance or through some sort of skill testing procedure. Both techniques were employed in this study. Although many apprentices were able to recall in surprising detail what they had learned during the course of their training, there were also some who were not altogether certain or honest about their skill competency. Therefore, it seemed that the only unequivocally reliable means to determine their skill level was to administer a skill test directly.

Since the author himself was not a mechanic by profession, he had to rely on others who were expert in this field for assistance in drawing up an appropriate test. Several experienced mechanics were consulted in Ghana, both African and Western, who helped greatly in putting together the form that was finally presented to a sample of apprentice mechanics during the last few weeks of the field research. The test was mostly a verbally administered test that was constructed of questions drawn from old London City and Guilds Mechanics Trade Tests (which is a trade test used in Ghana), trade tests of the Ghana

National Vocational Training Institute, and questions suggested by the mechanics consultants and the author. A copy of the final version of the skill test can be found in Appendix H.

While it would have been desirable to have used a test which called for the demonstration of practical mechanical skills on real apparatus, it was not possible to do so given the heavy expense and difficulty involved in assembling the equipment. Also, in Ghanaian wayside mechanics workshops, mechanics usually specialize in one or more specific models of cars or trucks which they become quite proficient in repairing. So it would be unfair to test mechanics using component parts that are familiar to one group but not another group. It was either necessary to use parts that would be equally familiar or else eliminate parts altogether and rely entirely on questions which test fundamental concepts and skills. The latter course was chosen, although a few standard parts were used in the test. The questions in the skills test ranged from items testing very simple workshop tasks and repair skills all the way to items testing complex problem-solving abilities.

Organization of the Study

The study is organized into five chapters. Chapter II places apprenticeship training in the wider context of artisanship and training in the informal sector of Africa. It briefly traces the history of informal skill training in Africa and then raises some of the larger issues that impinge on the operation of small-scale enterprises: for example, their relationship to the formal sector of the economy and to other forms of organized education and training, the patterns of access to training in various informal trades, and the concerns about production that must always be balanced against training needs.

Chapter III introduces the wayside mechanics workshop in its urban Ghanaian context. It describes typical wayside workshops as they exist in Koforidua and the social organization of work within those workshops. The terms of the apprenticeship agreement are discussed along with the backgrounds of apprentices and masters. This general discussion is highlighted through selected case studies of several master and apprentice mechanics. The chapter attempts to give the reader a basic feeling for the structure and operation of the workshops and their associated apprenticeships.

Chapter IV is the analytical core of the study. This chapter analyzes the data collected from the various instruments and draws out some of the more plausible conclusions. The discussion brings into focus the major theme of the study--the skill learning process--by identifying some of the major influences and constraints on that process. Some tentative interpretations are offered about the technical competence of wayside mechanics in light of their training, including some unique improvisational repair skills they possess. Whenever it is relevant, supporting evidence from the field of industrial skill training is woven into the discussion.

Chapter V begins with an overall review of some of the major conclusions of the study on the question of skill acquisition in the wayside workshop. The cognitive implications of apprenticeship training are then discussed briefly in relation to recent findings from experimental cognitive studies and in terms of possible intervention strategies. Supplementary skill training programs are considered as a possible approach to upgrading the skills of practicing artisans and suggestions are given on how such improvement programs might be designed, including a brief description of a recently implemented program in Koforidua. Following this, some potential areas of follow-up research on informal skill training are mentioned. Finally, the future prospects of small-scale workshops are assessed on their potential to serve as viable vehicles for development in African societies.

FOOTNOTES--CHAPTER I

[1] M. Grandstaff, *Nonformal Education and an Expanded Conception of Development* (East Lansing, Mich.: Michigan State University, Program of Studies in Non-formal Education, Discussion Paper No. 1, 1974).

[2] Ann Brown, "Development, Schooling and the Acquisition of Knowledge about Knowledge," in *Schooling and the Acquisition of Knowledge*, ed. R. C. Anderson, R. J. Spiro, and W. E. Montague (Hillsdale, New Jersey: Laurence Erlbaum Associates, 1976).

[3] Jean Lave, "Cognitive Consequences of Traditional Apprenticeship Training in West Africa," in *Anthropology and Education Quarterly*, VIII, No. 3 (1977), pp. 177-180.

[4] Alexander K. Luria, "Towards the Problem of the Historical Nature of Psychological Processes," in *International Journal of Psychology*, VI, No. 4 (1971), p. 269.

[5] Thomas Gladwin, *East is a Big Bird* (Cambridge, Mass.: Harvard University Press, 1970).

[6] R. Thomas Rosin, "Gold Medallions: The Arithmetic Calculations of an Illiterate," in *Council on Anthropology and Education Newsletter*, IV, No. 2 (1973).

[7] Sylvia Scribner and Michael Cole, "Cognitive Consequences of Formal and Informal Education," in *Science*, CLXXXII (November, 1973), p. 558.

CHAPTER II

INFORMAL SKILL TRAINING IN AFRICA

Introduction

Although indigenous craft workshops have long been familiar fixtures in urban centers throughout Africa, their existence has been "discovered" only recently by many economists, educational planners and others who are connected with economic development. For years following their independence, many African countries were committed to development policies that emphasized heavy industrialization and rapid expansion of formal education. Such policies frequently left little room for support of small-scale workshops in national development plans. Largely ignored were the contributions of small enterprises in producing many essential goods and services and in provision of vocational training to large numbers of young people. Small firms invariably were (and still are) written off in official parlance as "cottage industries" and their workers lumped together as "unenumerated" to underscore their unimportance.[1] It was widely assumed that anyone who was not regularly employed in a large firm or a government ministry simply had no respectable means of earning a living.

This thinking prevailed until the early 1970's when development policies in Third World countries began to undergo radical change. Fears had grown that political turmoil might soon erupt in some societies as a result of the ever-larger numbers of school leavers entering job markets and the widespread failure to create enough employment through industrialization. Planners began searching for other sources of employment to minimize the danger of political unrest. This search inevitably led to a new consideration of the small indigenous workshops and their role in what is now referred to as the informal sector of the economy. The potential of small enterprises to absorb unemployed youths and supply them with marketable skills was soon being studied intensively. Ironically, the very artisans whose existence scarcely was noticed only a few years before had begun to attract a sizeable and enthusiastic following.

This chapter examines the small craft workshop within the larger context of African society.* The primary focus is on the training function of small workshops in contrast to their admittedly larger role of producing goods and services. By concentrating on issues related to training, the chapter provides a background for the more detailed analysis of skill acquisition among wayside mechanics in Ghana in Chapters III and IV. The material also serves as an overview of some of the major issues being raised in connection with informal skill training in Africa.

Structurally, the chapter is divided into two parts. The first part traces the evolution of the small workshop from the closed, family-operated units of the past to the open, diversified operations of today. The second part looks closely at the efficacy of indigenous skill training and its relationship to other developmental concerns, such as formal and nonformal education, formal skill training, employment, and self-employment.

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*The discussion draws heavily on the general literature of the informal sector in Anglophone West and East Africa.

The Indigenous Craft Workshop in Historical Perspective

Traditional and Modern Crafts

Although interest in them is recent, small craft workshops are by no means new to Africa. On the contrary, they appear to have a long and vigorous history in much of West Africa and, to a lesser extent, in other parts of Africa as well. Production units for some of the more traditional crafts have been known to exist in that region since at least the earliest written accounts of those societies in the early nineteenth century. Indeed, nowadays it is not uncommon to see practitioners of the latest, most popular specialities plying their trades alongside craftsmen whose products and technologies have remained virtually unchanged for generations.

Since the end of World War II the informal craft sector has undergone an extraordinary transformation throughout Africa. Many new trades have suddenly come along to co-exist with older crafts and still newer ones are continually being taken up by enterprising young artisans. Small workshops now account for a far broader range of products and services than at any time in the past. For example, one investigator reported in 1965 that over half of the small businesses in one large Nigerian city at that time had been established only since 1956.[2] The opportunities presented by this rapid expansion of private entrepreneurship have helped to create an unprecedented demand for skill training among young people. Even such unlikely candidates as school leavers, who once disdained occupations involving manual labor, now seek to learn skilled professions through any available means of training.

Generally speaking, the crafts practiced today can be divided into the traditional (before the colonial experience) and the modern (since colonial times and after). Among the current crafts that existed in village and town life before the colonial era were blacksmithing, goldsmithing, weaving, carving, leathercraft, and herbal medicine.[3] Women, too, had their own specialized occupations, such as foodstuff preparation, pottery, soap-making, dyeing, and spinning, which continue today.[4] Carpentry and tailoring have been practiced in West Africa for many generations but apparently were introduced by early European missionaries in the nineteenth century. Modern trades like auto mechanics, welding, radio and appliance repair, tinsmithing, printing, and photography have appeared only in the last several decades of this century.[5]

The Traditional Craft Workshop

It is helpful to look at the traditional, pre-colonial roots of craft production in West Africa to better understand the modern craft enterprise. An appropriate conceptual framework for this task is provided by Udy's study of organized work in traditional and modern societies.[6] Udy classifies changes in the organization of work as societies pass through different stages of social development. He characterizes organized work in traditional society as primarily "socially determined."[7] That is to say, kinship and social relations exert a powerful influence on the performance of work, including, among other things, the determination of who does it, the kind and quality of products made, and the type of technology used.

This orientation toward the overall social environment endows socially determined work with a level of stability and permanence that is ultimately necessary in the transition to industrial organization. Unfortunately, this very condition poses grave problems for the effectiveness, efficiency, and innovative capacity of socially determined organizations. As Udy puts it:

> Because their members are oriented both to the immediate work situation and to the social setting, role content is at best split between work per se and other social considerations. It is hence impossible for members to work without also giving attention to non-work activities; indeed, the latter are likely to overshadow the former to the point where work itself becomes a by-product of a broader social situation.[8]

Organized work in traditional society is therefore inherently inefficient and not very adaptable to the imperatives of technology, especially "large-scale technologies requiring vast numbers of people and a highly complex division of labor." Since a high premium is placed on conformity to long-established social norms, new ideas and techniques, however progressive or imaginative, have little chance of being adopted if they happen to violate these norms. For these reasons, Udy concludes, socially determined work organizations are unsuitable for industrial production.

The notion of socially determined work is exemplified in the traditional craft workshop of West Africa, both in its earliest known form and in its urban equivalent of today. Before the advent of mass-produced goods, village necessities were manufactured in family workshops or production units where kinship matters had primacy over other considerations.[9] Certain lineages monopolized the production of various items. Their skills were considered to be the exclusive domain of the family and were usually passed down from father to son or other close relatives, rather than to outsiders who might be equally well qualified for training. The scale of production was small enough to be handled by the extended family without recruiting trainees from outside.

Advancement into a position of authority within the family production unit was (and still is) determined by ascriptive status, rather than by individual achievement or merit.[10] This preference given to age and family position offered few incentives for an ambitious young worker to attain exceptional skill mastery beyond what was normally expected of everyone. Moreover, lineage members were likely to frown on any attempts by an individual craftsman to give himself an economic advantage over his colleagues.[11] Entrepreneurial activities--for example, bulk-buying of raw materials for sale to other craftsmen or peddling the wares of other craftsmen in distant markets--were among the economic practices that probably aroused the disapproval of others. However, such behavior apparently was rare since workers understood well that the value of work was measured by its benefits to the community, not to the individual. While it helped prevent economic exploitation of the community by unscrupulous operators, this communal work ethic nonetheless insulated the traditional crafts from new technology, products, and organization.

Lest the traditional craft workshop be construed as a static and unprogressive institution, it should be added that there were features of traditional African society that softened its seemingly immutable nature. Using the Yoruba of Nigeria as a case in point, Koll, for one, argues against the view of pre-colonial craft production as a "simple and unalterable system."[12] In addition to the usual training of family members, craftsmen were also supplied to a traditional community from among the refugees of frequent tribal wars and through the training of slaves owned by master craftsmen, thus broadening the base of the established craft families. Fadipe also points out in his study of the same culture that entry to the handicrafts was not restricted to the immediate family and that a son could take up a different trade than his father's simply by paying a fee to the "appropriate organization."[13] Specialization was encouraged as well and was quite elaborate in the traditional crafts, considering the simple technology that was used. Yet, despite these qualifications, the traditional craft workshop of West Africa did not deviate in any fundamental sense from Udy's conception of a socially determined organization.

The Emergence of Contractually Organized Work

According to Udy's model, these earlier familial forms of socially determined work will give way under certain conditions to more modern forms of organization.[14] The pivotal development in this transition to more advanced work organization is the appearance of contractual forms of labor. Though at first temporary and accepted more out of necessity than of choice, contractually organized labor represents a major step forward in the evolution of work. The main asset of the contractual form seems to be its capacity to re-orient the work organization toward the technology and away from the social environment. As Udy puts it:

> No work organization can achieve a specifically technological focus unless it enjoys a considerable degree of autonomy vis-a-vis its social setting. Contractual organization is the only form of socially determined work offering this possibility. Familial and political forms are imbedded in diverse social obligations. Contractual forms, in contrast, focus on specific problems with which the parties involved are concerned. . . . It is thus through the growth of contractual organization and its interaction with various circumstances in the social setting, that the transition from socially to technologically determined forms of work is engendered.

A purely contractual system does not suddenly appear, however. It is often preceded by one or more "proto-contractual" forms, such as age-grade associations, which hire themselves out for short-term work as collective bodies, and mutual aid societies, which perform work for their members on a reciprocating basis.[15] The more permanent and familiar kind of contractual organization that involves the hiring of others to work for pay--i.e., the individual contract--requires at least three conditions: 1) a shortage of familial and forced labor while at the same time an adequate supply of contractual labor; 2) a means of rewarding workers for their work, and 3) the existence of a commercialized monetary economy to perpetuate the new order in the long run.[16] To the extent that a contract calls for the performance of explicitly specified services, as opposed to diffuse services, it has become in Udy's terms a "job-specific" contractual arrangement. Only job-specific contracts appear to have the potential for creating the technological orientation necessary for modern industrial organization.

Contractual Organization in Africa. Evidence of contractual forms of organization are not difficult to find within the craft sector of West Africa. Indeed, they seem to have gained a firm foothold in the craft sector of West Africa just as the earlier family-based organization began to decline. According to Udy's model, these two developments are by no means unrelated.

The rise of contractual organization in this century coincided with fundamental changes in West African society that have had a profound impact on the traditional production unit. Perhaps the single most important event was the expansion of foreign trade, which exposed West Africans for the first time to a wide variety of new products and technologies from abroad.[17] This exposure to imported goods, coupled with population growth, migration to the cities and broader internal trade, created huge demands, not only for the products themselves, but also for the specialized services for making or repairing them locally. The family production unit, with its mostly rural line of products and its strictures on entry, was simply not equipped to handle these new functions.

To begin with, the simple technologies used in producing traditional articles usually were not applicable to the new trades. For example, it is difficult to imagine a traditionally trained blacksmith applying his skills to the repair of automobile engines or even the reconstruction of damaged automobile bodies without extensive re-training.

Even if traditional craftsmen could have adapted to these new skill areas, they lacked the sheer numbers to meet the expanding volume of business. As Lloyd has noted, a father could train in his lifetime only a few sons to take his place, while a modern master can train as many as two dozen or more in his active career.[18] The traditional crafts thus suffered from a manpower shortage that could be overcome only by their transformation into non-kinship-based, inter-tribal training systems.

New Trades. A major stimulus to the modernization of the West African craft structure was the introduction of on-the-job vocational training in West Africa during the early decades of the twentieth century.[19] With the establishment of state-owned railways, public works, posts and telegraphs, and marine departments by the colonial government, and, later on, motor mechanical workshops by large expatriate firms, a cadre of Africans was trained in technical trades that had no obvious parallels in traditional society. Among the new categories of skilled manpower were the mechanics, machinists, electricians, and numerous "general repairers" who were trained to maintain the vital transportation system. As many of these artisans eventually left their jobs to set up businesses of their own, they became the first private wayside mechanics, welders, auto-electricians and auto body rebuilders. In addition, their all-around training often became the source of an even greater diversity of private trades, when those who received training from them branched out into lines such as bicycle and watch repair, bucket and drum making, and sieve making.

Reward System. Just as significant as the new trades was a new motivational instrument--the financial reward for work. The vast army of skilled and unskilled workers who toiled in the European-supervised workshops and offices often did so not because of any sense of duty, but rather out of anticipation of the wages and salaries they were promised. Yet the idea of receiving a financial reward was undoubtedly quite novel to these early African employees, who were unaccustomed to selling their labor to others. Fadipe points out that one's labor was given freely on a mutually reciprocal basis in the village.[20] The same was true even for members of quasi-contractual organizations like mutual aid societies. In the case of the family production unit, the reward for one's work was the sense of fulfillment in performing an important social obligation and the right to share in the product. The colonial workshop and office, as transplanted institutions from an alien culture, had no legitimate grounds to invoke such customary incentives and were obliged instead to offer extrinsic rewards for work.

While money was the work incentive in the colonial establishments, the incentive for work in the small African workshops that evolved from them was the simple expectation of learning a trade. Thus, the notion of rewarding a worker for his labor became translated into a master's promise to train rather than to pay. Indeed, it was soon customary for master craftsmen to expect a payment for disseminating their skills to apprentices.

But along with the master's expectation of a fee came the need to delimit the apprentice's traditional obligations. The open-ended training of the family production unit, which entailed years of service to one's father before reaching master status, was no longer acceptable where payment of a fee was concerned. An apprentice who was paying for his training expected to become fully qualified to earn a living in a reasonable period of time. Therefore, a training system was emerging within the modern workshop in which the essential conditions of the experience were expressly agreed upon by all parties and consummated in a written document. With this step contractual organization had made unmistakable inroads into indigenous skill training.

Migration. One of the most visible social trends of recent decades has been the enormous migration of youths from rural to urban areas in search of education and job training. Margaret Peil, for example, discovered that almost half of the skilled craftsmen in the West African towns she surveyed over the last ten years had migrated for their apprenticeships.[21] Callaway's study of the small craft sector of Ibadan estimated that 70 per cent of the apprentices in small workshops were from outside the Ibadan province, compared to only 47 per cent of their masters.[22] That such wholesale migration has continued apace is confirmed in a recent study of informal sector mechanics in Ghana, where only nine per cent of the respondents listed hometowns that were the same as the towns in which their firms were located.[23] Much the same holds true in East Africa, where long-distance migration in search of skill training is equally prevalent.[24]

The increasing volume of migration for purposes of skill training is a clear indication of the spread of contractual organization into the craft sector. In fact, the rapid proliferation of small workshops which are not organized along kinship lines has been made possible by the ready availability of apprentice labor through migration. Because of the growing demands for the products and services of the modern crafts, more apprentices were needed than could be recruited within the families of artisans or in nearby communities. The opportunities made possible by the expansion of these trades have attracted young people in need of jobs and skills from increasingly distant places.

Changes in Recruitment Patterns. Trades which have no historical associations with certain lineages are, in principle, open to anyone with the interest and qualifications to receive training. One might expect, therefore, that the masters who practice these trades would select their apprentices on explicit, job-related criteria, given the more complex technology of some of their trades and their freedom to train non-kinsmen. Yet, in practice most informal masters recruit apprentices on fairly general qualifications. At this point in their development, small establishments simply lack sufficient division of labor among their workers to warrant any truly job-specific recruitment.

Nonetheless, many modern masters are now more aware of how the previous backgrounds and personal attributes of apprentices can affect their learning or performance of the work. Recruitment practices have changed noticeably in accordance with this new awareness. For example, some masters are now reluctant to accept close relatives such as sons or brothers as apprentices.[25] One of the reasons commonly given for their reluctance is the belief that family considerations might interfere with the master/apprentice relationship and lead to discipline problems with the other apprentices--a concern that was unheard of in the family-operated workshop. Other factors such as character, the amount of formal education, and friendship with the master are now often seriously considered in deciding whom to accept as apprentices. Later in this chapter the preference of many masters for educated apprentices will be discussed.

Conversely, it is not uncommon today for a prospective apprentice's family to select a master for their son's training on the basis of the master's integrity and reputed skill, rather than on any close kin ties they may have to him.[26] In the present study of Ghanaian wayside mechanics, numerous apprentices cited the good reputation of their master as the main reason for their wanting to be apprenticed to him. There was even a measure of pride among the apprentices of well known mechanics in knowing they were learning their craft from a master of such wide renown.

In both cases, traditional customs and attitudes that once were unquestioned have been cast aside somewhat in favor of concerns about performance, quality, and efficiency. Obviously, these changes do not represent the kind of technological orientation or elaborate division of labor required of industrial organizations. But, clearly, the small craft workshop has been loosened from its old social moorings and invested with some of the contractual trappings of modern work organizations.

Vestiges of Tradition

Despite the trend toward contractual forms of organization, vestiges of the earlier familial form still remain deeply entrenched in the small craft sector. Many of the contractual features that have just been described apply almost exclusively to the more modern trades. Traditional blacksmithing and weaving, for example, are still dominated by certain lineages and entry into these crafts is limited to members of these families.[27] Although they now work independently for their own profit, the artisans of these crafts share a common workshop and communally display their products. They continue to make many of the same traditional products using the same ancient tools and techniques. The workshops of blacksmiths, and, to a lesser extent, weavers are still located in their original family compounds, which often are found in obscure parts of large marketplaces.[28] Even with compelling economic reasons to relocate to more visible places or to actively market their wares, they cling to the belief that customers will find their way to them.

Just as some masters now prefer to train non-kin apprentices, other masters, particularly carpenters and blacksmiths, remain partial to training relatives or members of their hometowns or ethnic groups. The fostering apprenticeship, where a very young boy (usually kin) is apprenticed for an extended period for little or no fee and with no written agreement, is a throwback to the traditional father-to-son training.[29] In this case the master acts as the boy's surrogate father with more or less total control over his working and private life. As in the family production unit, the apprentice's long period of service to the master is considered adequate compensation for the training given to him. This arrangement, while more common among the long established trades, can be found on occasion even among the modern crafts.

Visible continuity with the past is apparent even with artisans who accept only non-related apprentices. As noted earlier, it is now standard procedure in many trades for the master and the apprentice's family to draw up a formal written document stating the terms of the apprenticeship. Curiously, however, these agreements are more apt to embody traditional sentiments than to specify the exact training regimen to be given (as will be seen with the apprenticeship agreements of wayside mechanics in Chapter III). In addition, the completion of an apprenticeship is frequently celebrated with a highly ritualized ceremony, in which traditional blessings are offered for the tools of the newly freed apprentice. A personal testimony is awarded the new journeyman attesting to his loyalty and hard work to his master and confirming his competence in the eyes of the master. Some masters may even present apprentices who have served long and well with a token tool or two, much as fathers in some African societies were expected to furnish their sons with tools, land, and a house upon passage into adult life.

Implications of Informal Skill Training

The training function of small workshops has become a topic of special relevance given the continuing expansion of the craft sector and the recent efforts to harness its developmental potential. This part of Chapter II examines some of the significant issues related to training in small enterprises. The intention here is to provide only a cross-section of current thinking and not an exhaustive review of skill training in the informal sector. The discussion, therefore, is organized around several general themes which surface repeatedly in the literature on informal skill training.

The Formal/Informal Interface

Formal skill training has co-existed with traditional informal training systems since the establishment of colonial workshops in West Africa. From that time, these two sources of skill acquisition have been in an almost continuous state of interaction and cross-fertilization, with both leaving identifying marks imprinted on the other. To some extent the origins of their interrelationship have been so obscured over time to be scarcely recognizable today. For example, it was pointed out earlier that many technical skills, including several modern trades now practiced by thoroughly "indigenous" artisans, can be traced to the training given to African workers in early government workshops. Other artisans who have long been firmly ensconced in the informal sector learned their crafts through quite a different formal route--colonial military service during World War II. Still others got their start in a technical institute or in one of the other formal trade courses that now operate in many African countries. In East Africa, the first generation of African craftsmen in many trades succeeded in acquiring the skills of the Indian craftsmen who had formerly dominated the craft sector.[30]

Technical practice in the informal sector continues to be influenced profoundly by the diffusion of skills and technology from the formal sector. By far the greatest impact still comes directly from on-the-job training in large firms. For example, a sizeable proportion of the mechanics, auto-electricians, welders, and body specialists who are trained by large automobile dealerships and government workshops eventually leave their jobs and set up workshops of their own.[31] Except where heavy capital outlays are required for equipment, their knowledge of the processes and organization of the large firm is carried with them into self-employment and passed on to their apprentices. Any technical innovations these artisans might introduce gradually will filter through the entire informal industry until they become widely accepted as standard operating procedure.

However, the effects of formal sector technology are not felt exclusively from training. New ideas and techniques sometimes are transmitted through less obvious channels. Smutylo describes a Ghanaian carpentry workshop that is able to reproduce the latest styles of a large furniture factory simply by hiring carpenters from the factory to build plywood patterns of the styles on weekends.[32] In a less direct link with the formal industry, tailors often learn to make new fashions by copying the designs in magazine photos or from drawings and garments brought by customers.

Skill transfer works in reverse as well. Informally trained craftsmen regularly find their way into wage-earning employment in formal sector firms. Although opportunities exist for a variety of tradesmen, prospects for employment seem best for mechanics, carpenters, and printers, who frequently secure jobs in large mechanical workshops, furniture factories, and printing establishments. In his survey of the automotive industry, for example, Hakam discovered that nearly one third of the technical labor force of formal sector firms had received some training in informal workshops.[33] Evidently, many employers prefer to hire applicants with practical experience in small workshops over technically educated school leavers who, they fear, may soon leave the firm if not quickly promoted to managerial positions.

This continuous two-way transfer of skills may even result in a rather heavy flow of human traffic between the two sectors. Heightening this effect are the multiple shifts in occupation made by some artisans, beginning typically with an informal training experience, followed by formal employment in the same trade, in turn followed by informal self-employment, and so on. Such back and forth movement between the two sectors is particularly common in East Africa, where the choice of how one ultimately earns a living is not necessarily related to initial training. It is not unusual for young Kenyan artisans to engage in a flurry of short-lived activities until one that promises permanent security is found.[34] By contrast, intersectoral movement in West Africa is much less hectic, at least among those who have been trained in conventional apprenticeships, and is usually associated with young journeymen who must work for others until they can purchase their own tools, or with less successful artisans who cannot find security either as an employee or in business for themselves.[35]

Blurred Distinctions. In a variation on this theme, King argues that the distinctions between formality and informality, at least in the East African economy, may be so blurred as to render any rigid demarcation of the two utterly useless.[36] He cites a number of areas such as products, work sites, recruitment, income, and training where qualities often ascribed to the informal sector apply just as validly to large portions of the formal sector. On the issue of training, for example, indigenous artisans in some trades apparently do not differ greatly from their formal sector rivals in terms of the training they are given as apprentices. An informally trained mechanic, King maintains, is generally competent to practice his craft either in a workshop of his own or, with minimal retraining, in any modern automobile franchise.

To be sure, the small-scale, labor-intensive sector does have some exclusive functions that cannot be duplicated easily by the large-scale, capital-intensive sector, and the converse is equally true. But even where major differences exist, neither sector is likely to enjoy complete independence from the other. Certainly this is the case with the informal metal fabricators of Kenya, who depend heavily on scrap metal from the formal petroleum industry for the raw material from which they make their inexpensive line of household commodities. In King's view, these intricate interconnections between the formal and informal divisions of the economy must be well understood if attempts to tinker with any one part of the process are not to cause unintended and undesirable side effects at other points in the system.

Informal Skill Training and Education

The relationship of indigenous skill training to both formal and nonformal education is a topic of considerable relevance, especially in view of the current interest in creating more training and employment opportunities for schooled youths. Historically, many experts have emphasized the apparent conflict between schooling and apprenticeship training. One widely held view was that schools socialize students to look down on manual labor and to expect white collar jobs in the government or in large private firms upon leaving school. During the colonial era and in the years immediately afterward, employment was openly regarded as the one assured way of attaining upward mobility. As school leavers were rewarded with clerical and supervisory positions, their unschooled peers who opted for manual trades were greeted only with low paying jobs and unemployment.

Observers of the informal sector agree that formal education has exerted a powerful influence in shaping the aspirations of students towards wage sector employment. But they disagree on how uniform that influence is over the entire spectrum of education. Callaway, for example, contends that formal schooling in general has an "uprooting" effect on those who are exposed to it, isolating them from their own local environment and infusing them with alien and unrealistic expectations. As he puts it, "Modern formal education, by the nature of its disciplines, necessarily creates a discontinuity with indigenous learning."[37]

King, on the other hand, takes a somewhat different view. While agreeing with Callaway insofar as secondary education is concerned, he rejects the notion that primary schooling irrevocably orients students towards the most elite occupations in the society.[38] Indeed, the conditions under which most primary schools operate in Africa hardly equip them for that task. The typical primary school is not a separate world to itself but is bound up in the routine of community life. Teachers are usually drawn from the community and the physical facilities of the school itself are simple and unassuming. In addition, rural primary students are well accustomed to combining their attendance at school with regular work on the family farm. If nothing else, the primary school is notable by its very "ordinariness."

In contrast to the primary school, the secondary school in Africa does appear to fit the familiar stereotype. To begin with, the relatively few middle school leavers who survive the academic and financial hurdles to entering secondary school are automatically accorded a special status. Once admitted, they find a learning environment very different from the primary school they just left. The physical location of many secondary schools on the outskirts of towns isolates them from the mainstream of community life. Instead of the simplicity of the primary school, they experience an elaborate world of "real uniforms, stone buildings in a large compound, some expatriate teachers, and regulation-sized classes."[39] Even the regimentation of the school schedule with its "set periods, bells, short breaks, and regular leave" clashes with the familiar pace of work on the village farm and in the informal workshop.[40] As King concludes, "One of the main messages of the secondary school--whatever the ideology of the government--is its exclusiveness and specialness."[41]

A few lucky secondary leavers can take advantage of this indoctrination by securing jobs in the small modern sector of multi-national companies, large domestic firms, and government bureaucracies. But their less fortunate classmates are increasingly being forced into alternative avenues of employment. Here they may be ill-equipped to make the transition. Their socialization into an educational institution so thoroughly oriented toward the elite professions has probably left them with little appetite for either manual work or self-employment, which perhaps accounts for the noticeable lack of interest in apprenticeship training among secondary school leavers.

Education for Self-Employment. The attitudes toward work that students develop in school are now a matter of some concern. The fact that school leavers are increasingly those who are unemployed has prompted many educators to ask whether the educational system should not be modified in some way to actively promote opportunities outside the formal wage sector. For example, some experts believe that by incorporating a pre-vocational component in the primary curriculum students could be enticed to seriously consider self-employment in the skilled trades. The rationale behind this recommendation is the assumption that traditional barriers between "school skill and community skill" could be broken down by bringing aspects of work in the surrounding community into the school curriculum.[42]

School reforms have included everything from introducing standard pre-vocational courses in the primary curriculum to actually setting up primary school production units.[43] Some countries have gone beyond the confines of the school to proclaim a national philosophy of manual work for students and lifelong study for workers. Rather than simply reproduce existing craft skills, other nations are trying to develop student technical innovators who can go out into the community and put their ideas to work. At the secondary level, the so-called "diversification" movement represents an effort to divert some secondary students away from the university stream and into a pre-entrepreneurial track.[44]

While many of these efforts are genuinely necessary, the vocationalization of the formal school has in practice not had the positive impact on informal artisanship that had been expected. Simply stated, the problem seems to be in using a formal institution for a non-institutional purpose.[45] Skilled trades can no doubt be taught in school, but there is no guarantee that the students who are trained can or will put their skills to any practical use after leaving school. For instance, curriculum planners may not have accurately anticipated market demands for certain craft specialties. As a result, the field may already be too crowded for any new entrants to earn a decent income at their work.[46] Or school-trained artisans may lose interest in practicing their trades once they discover that the tools, equipment, and facilities used by working artisans do not measure up to those they were accustomed to in school. Even with a strong national commitment to integrate work and study, schools have had extraordinary difficulty in replicating the real world conditions of work.[47]

Introducing a pre-vocational curriculum package or turning the school into a production unit cannot by itself increase the number of school leavers who go into skilled self-employment. Nor can the full-fledged vocational programs of the technical secondary school. Often overlooked is a crucial difference between the purely cognitive aspects of the skills themselves and the attitudinal context in which they are imparted.[48] The technical secondary school, for example, would seem on the surface to afford maximum preparation for the skilled technical trades. But the all-important social climate of the school tends to militate against permanent manual work in favor of supervisory status. Ironically, skill training in school acts not so much as an entry to skilled work as, in King's words, a "preparation for leaving skilled work."[49]

Is Schooling Really a Barrier to Informal Skill Training? In reality, formal schooling is not the disincentive to entry into the informal economy that the above discussion implies. Indeed, the school may be entirely superfluous to the task of motivating and training young people for self-employment. As King points out for East Africa, large numbers of young educated Kenyans have already found their way into the informal sector despite their schooling and without any particular pre-vocational bias in their education.[50] Studies elsewhere in Africa suggest that schooled youths in those countries are flocking to skilled trades in equally large numbers. Aryee's data, for example, cite an increasing level of education among the owners of informal sector firms in Kumasi, Ghana.[51] Smutylo's study of informal workshops in Accra reveals a similar educational advantage of apprentices in relation to their masters.[52] Apparently, occupational choice is being determined less by the schooling experience than by the harsh economic reality in the society at large.

As jobs in the stagnant modern sector have grown scarce, school leavers and dropouts from all levels of education have been forced to consider the very same informal earning opportunities they would have shunned only a few years earlier. Rather than admit failure and return to their villages, many choose to stay on in the towns and cities, trying their luck at everything from street hawking to apprenticeship training. Their quiet resignation to these unexpected "degradations" often disguise a real inner desperation. Brokensha described the agonizing ordeal of one secondary school dropout as he bounced along from one subsistence activity to another in a futile search for steady work.[53] That the frustrations of the unemployed young have not as yet galvanized them into organized political action is a testimony to their unshakable belief in eventual success, even in the face of utterly bleak employment prospects.[54]

Although they may be similarly dependent on informal opportunities for their livelihood, leavers from different levels of schooling differ considerably in the types of activities in which they participate. As expected, those with at least some secondary education normally regard any involvement in the unorganized sector as a temporary diversion that must be endured while maneuvering for a breakthrough into permanent employment. They tend to restrict themselves to highly casual "vocations" that can be dropped momentarily should a better opportunity appear. Individuals with only middle school qualifications or less, however, have little hope of securing an unskilled job in the formal sector that would match what they could earn eventually as a skilled artisan. Their most realistic strategy is to sacrifice immediate gain for a secure, if perhaps modest, future income. Consequently, many unemployed middle school leavers sooner or later end up learning the rudiments of a trade in one of the indigenous apprenticeships.

Just as middle school leavers now seek security in the informal trades, many master artisans have begun to recruit more educated apprentices in recent years.[55] This is particularly true in the more modern trades, such as printing and electrical repair, where literacy skills have a direct relationship with the work. For example, in Peil's 1968 survey of 233 apprentices in Accra, 100 per cent, 62 per cent, and 68 per cent respectively of the apprentices in printing, radio repair and motor mechanics had completed their middle school education.[56] By contrast, only 32 per cent and 19 per cent of the apprentices in goldsmithing and carpentry--two traditional crafts--had completed middle school. Among the reasons Peil's masters gave for preferring schooled over unschooled apprentices is that they can learn faster, can read trade books, can keep accounts and make measurements, and can talk to customers in English.

Nonformal Education and Skill Training. Nonformal educational programs dealing with skill training have emerged in recent years as a much-heralded alternative to formal vocational education and as a supplement to indigenous skill training. While operating independently of the formal educational establishments, nonformal skill training is distinct from informal sources of skill in that it constitutes a structured experience consciously intended by both sponsor and learner to promote learning.[57] Coombs and his associates have catalogued a rather wide spectrum of nonformal skill training programs in developing countries and has classified those programs under three categories: (1) technical skills training for older adolescents and young adults; (2) technical upgrading of existing artisans and craftsmen, and (3) comprehensive small industry promotional schemes.[58] Some examples of nonformal skill training in Africa which illustrate this great diversity are:

> --the Village Polytechnics of Kenya, a nationwide system of local non-boarding training centers designed to develop artisanal skills relevant to the specific needs of each village;
>
> --the Vocational Improvement Centres in Northern Nigeria, which are intended to upgrade the technical skills of working artisans and journeymen in Northern Nigeria;
>
> --the Rural Artisan Training Program in Senegal, the aim of which is to develop an elite cadre of rural artisan entrepreneurs capable of performing skilled non-farm work such as manufacturing and repairing farm implements and constructing houses.

Nonformal skill training programs appear to compare favorably to formal skill training programs on several important dimensions. According to Coombs, the more innovative nonformal programs are better adapted to learner needs, less costly, more cost/beneficial, and potentially more flexible, convenient, and locally self-sufficient than formal programs.[59]

There is no paucity of small, dynamic nonformal skill training programs that show great promise. Yet, nonformal skill training generally has not lived up to the expectations of its most ardent supporters. Coombs cites three general problems afflicting many programs.[60] One problem is the overly rigid replication of successful pilot projects to new settings where the local conditions may be quite different. Also, nonformal skill programs often fail to assess realistically the needs of proposed clients (i.e., what a foreign expert thinks clients need is not always what they think they need). Thirdly, there has been a decided lack of follow-up support to trainees in terms of helping them apply what they have learned. Coombs, however, characterizes these weaknesses as "not fatal defects but rather promising points at which to improve and thereby boost their productivity."

King contends that nonformal skill training sometimes is caught in an unfortunate paradox. On the one hand, nonformal skill programs are often unpopular with school leavers because they represent "not so much a second chance, as a second (inferior) track."[61] On the other hand, when nonformal programs do achieve a measure of popularity, they are invariably pressured by their young participants into adopting the trappings of the very schools that they set out to replace.[62] The Village Polytechnics' concession to certificate granting, trade testing, uniforms, boarding facilities, etc., is one of the more celebrated examples of such deviation from an original ideal.

Some of the misgivings over the changes within the Village Polytechnics could have been avoided, says King, if sponsored nonformal programs like the V P's had been seen as being in the middle of a skill continuum, extending from formal technical institutes on one end all the way to indigenous, on-the-job skill training on the other end.[63] The gradual absorption of the Village Polytechnics into the "formal" mainstream then becomes more understandable if one appreciates how many skill training alternatives already exist for prospective trainees at the opposite informal end of the skill spectrum. A real challenge for nonformal skill programs will be to work more closely with and supplement many of these indigenous skill training arrangements.

Access to Skill Training.

A major factor determining the impact of informal skill training in Africa is the degree to which potential trainees have access to specific training opportunities. As noted earlier, access to some of the traditional West African crafts has been limited to members of certain lineages, which restricted the numbers of such craftsmen to the relatively few sons and other close relatives trained by the father. Now all but a few traditional crafts are open to both kin and non-kin and to other ethnic groups from outside the community and the region. Virtually any young man from any part of the country who can locate a master willing to accept him as an apprentice has the option of learning a trade.

The exact criteria used to select most apprentices today, while undeniably open by traditional standards, nonetheless limit entry into the informal trades to those who fit the needs and preferences of each master. Few masters accept just anyone who comes off the street to apply for an apprenticeship, no matter how acceptable he may seem nor how depleted his ranks of apprentices may be. Even masters whose businesses are expanding rapidly and are in need of several apprentices will use some discretion in deciding whom to accept. If nothing else, they will give an aspiring apprentice a trial period in which to prove himself. Many masters require some guarantee or backing for the candidate; hence, the appearance of the written apprenticeship agreement. As a general rule, the more prestigious the master and the more popular his trade, the more selective he can afford to be about whom he admits as an apprentice.

The cost of an apprenticeship is another factor that potentially limits access to informal skill training. In West Africa, apprenticeship fees vary from no payment at all to various combinations of cash and material goods.[64] Peil observes that modern urban trades call for a mostly cash payment, while in traditional rural-based crafts the bulk of the payment is made in goods. The fee for a radio repair apprenticeship, for example, is relatively large and paid for entirely in cash. Carpentry, on the other hand, involves a small cash payment in addition to some food and drinks. The smallness of the carpentry fee, in Peil's opinion, is intended to compensate for the long period the master benefits from the apprentice's labor. Thus, the amount an apprentice must pay for his training would appear to be inversely proportional to the value of his labor to the master. Interestingly, apprentices in printing, the trade most closely associated with literacy, receive wages rather than pay for their training.

Generally speaking, apprenticeship fees probably are not an insurmountable barrier to entry into the informal trades. In fact, the inflation-corrected cost of apprenticeship training actually may be less than it was twenty years ago.[65] In this light even an expensive informal apprenticeship may seem reasonable to those who cannot afford the still higher cost of secondary school. And it must not be forgotten that part of the money paid to the master is returned to the apprentice incrementally in the form of daily allowances and perhaps token wages after the apprenticeship is officially completed.

Yet the task of accumulating enough money to make the initial payment can still tax the meager finances of a poor rural family, perhaps delaying the start of training and conceivably preventing it altogether in some instances. The fostering type of apprenticeship, which usually requires little or no cash payment, may be the only alternative for a financially strapped family, provided they happen to have kin or hometown ties to a master artisan.

The length of the apprenticeship and the subsequent journeymanship (or "thanking period," as some call it) can also affect access to the skilled trades. Since most masters accept new apprentices only to replace those who finish and leave, the number of openings for new apprentices is therefore a function of how quickly the training cycle is repeated in a given trade. That cycle is subject to considerable variation depending on the trade. For example, in trades such as photography and cornmilling, the apprenticeships are typically brief, ranging from six months up to two years.[66] The apprenticeships of mechanics, shoe-making, carpentry, and welding, however, are far longer, often lasting three to five years or more.[67] It follows from this that the places for new apprentices should be fewer in trades which reproduce skill more slowly than in trades with rapid reproductive cycles.

Interacting with the length of the apprenticeship is the size of the average workshop and the number of such establishments in each trade. For example, the training period might be long, as with mechanics, but the number of openings for new apprentices still numerous because of the relatively large number of apprentices in each workshop. Or, similarly, as in tailoring, the total number of openings for apprentices could be high, despite the small size of the workshop, because of the fairly short training cycle and an abundance of practicing masters.[68] In contrast, traditional blacksmithing, with its long apprenticeship, scattering of workshops and few apprentices, seems to have all the characteristics of a slowly receding craft.

The question of access to skill training assumes somewhat different dimensions in the case of East Africa. Apprenticeship arrangements appear to be less formalized than in West Africa, due in large part to the lack of an established craft tradition and the more recent emergence of an African artisan class in East Africa.[69] Fees are required for many apprenticeships as they are in West Africa, but King insists that these are not so onerous as to restrict entry. In fact, the training among some of the so-called "wasteland fabricators," who were mentioned earlier, is so remarkably open and short-cycled that it defies comparison with the structured apprenticeships of West Africa. The easy accessibility and rapid skill turnover render these specialties highly attractive to many rural youth who seek a quick and inexpensive way to learn a trade. Even in the more established trades like automotive repair the length of the training period seems to be far shorter than in the same trades in West Africa. The price that the

East African artisan pays for this kind of accessibility, of course, is far more competition at the time he begins practice as a qualified master.

Production Versus Training

One of the most controversial questions about indigenous skill training is whether adequate training is possible in an enterprise whose most visible function is to produce goods and services for a paying public. The skeptics inevitably suspect that training is given short shrift in such establishments, while masters freely exploit the labor of their apprentices. More sympathetic observers argue that masters rarely exploit apprentices knowingly, but, in fact, provide a practical, hands-on type of training at lower cost than formal technical trade schools. Whether informal skill training is indeed a form of inexpensive training or simply cheap labor is a familiar theme in the literature and has been the subject of numerous governmental debates on possible regulatory action.

Like any complex issue, this question is not easy to resolve. There is a tendency to see things in a way that confirms one's own preconceptions. An example will illustrate. A recent study of small operators in Ghana indicated that workshops with larger numbers of apprentices also have more journeymen than smaller workshops.[70] The author concluded from this that the larger number of journeymen is a reflection of the master's keen interest in training his apprentices well. However, one might conclude just as correctly that the master was concerned more about the quality of his product (and therefore his reputation) and employed more journeymen to insure that young and inexperienced apprentices made no major blunders nor handled the work in a careless manner.

Generating Capital. One particularly tempting abuse of the apprenticeship system concerns the use of apprentice fees as a means of generating needed capital. Apprentice fees may be the only source of capital for small informal operators, since they have so little access to loans from commercial banks. This source can be especially important to a master who is just entering self-employment.[71] His ability to attract enough fee-paying apprentices in the early stages of his practice may determine whether he will have the capital to purchase the essential tools and equipment or be forced to make do for months or even years with only the semblance of a workshop. Apprenticeship fees probably comprise a smaller part of an older firm's capitalization, but here too they still may be important if the master is considering a major investment.

The use of apprentice fees for initial or operating capital is not in itself an abuse, of course, unless the master takes on more apprentices than his business justifies. According to Callaway, such behavior is probably rare among informal artisans, who are for the most part conscientious about their training mission.[72] Occasionally, though, cases of apprentice overload and other abuses do crop up, particularly in large cities and in certain trades like the construction industry where unscrupulous individuals find it easier to operate. But one should hasten to add that even when a master has an excess of labor, he may not be guilty of exploitation, since the unneeded apprentices may be relatives that he was more or less obligated to accept.

East Africa has a similar problem in a more extreme form. There, skilled artisans sometimes dispense with the production aspect altogether and teach their skills to trainees in store-front "technical academies."[73] Many of these "garage-cum-schools", as King refers to them, have, for all practical purposes, "crossed into the formal sector" by setting up boarding facilities, advertising for trainees, and seeking accreditation with the Ministry of Education. Not only is the training in the academies relatively expensive, but it is also mostly inferior to conventional apprenticeships. Yet, programs of such questionable quality manage to thrive because of the passion for training and self-advancement among Kenya's youth.

Extending the Length of Training. Another sense in which the issue of labor exploitation is sometimes raised is in relation to the length of the apprenticeship. As Chapter IV will make clear for motor mechanics, skills are acquired through a gradual developmental process. It should come as no surprise, therefore, that an apprentice becomes more valuable to a master the longer he remains in the firm. One of the master's main incentives in assuming the role of trainer is his expectation of being the first to benefit from the skills he has nurtured so painstakingly in his apprentices. He naturally would feel justified in trying to maximize his own benefit by extending the service of his apprentices as long as possible.

Masters have been known to use a variety of ploys to hold on to their qualified apprentices, including paying them small wages and promising to use personal contacts to find them jobs.[74] But the most systematic mechanism for discouraging premature departure is the elaborate socialization of apprentices into the sub-culture of the workshop. From the moment he enters training, an apprentice learns to subordinate his own desires to the service of his master. His behavior at all times is expected to reflect humility and unflinching devotion. Therefore, when it comes time for his freedom, he usually has little quarrel with the obligation to stay on and help his master for at least several months. In practice, however, some of these journeymen end up working in their master's workshop for several years.

The alleged discrepancy between the time necessary to teach the skills and the actual length of the apprenticeship has inspired comment from some authorities. King questions whether there is any need for the long apprenticeship in West Africa from a purely technical perspective and agrees by implication with the familiar view of labor exploitation, while elsewhere acknowledging the important socialization role played by an extended apprenticeship.[75] He contrasts the situation with the short East African apprenticeship where apprentices quickly progress to master status; in part, because a master apparently has no sanctions "to hold on to his trainees beyond the time they wish to stay." However, the "rough and ready" type of artisan on which King concentrates his attention and which typifies much of the Kenyan artisan landscape is hardly comparable with the more comprehensively trained and financially prosperous craftsmen of West Africa.

There may be defensible reasons for a long apprenticeship. This study (see Chapter IV) investigates the possibility that a prolonged apprenticeship, in fact, may be necessary to experience the full range of possible tasks, particularly in the more technologically complex maintenance trades like motor mechanics and in crafts involving custom-made products. It is also true that an individual who spends five or six years as an apprentice/journeyman learns more than just the technical skills of his trade. He learns the finer points of customer relations and how to supervise other workers; picks up cost-cutting shortcuts; makes contacts with spare parts or raw material dealers, and cultivates the beginnings of his own clientele. In short, he masters an entire business. His long period of loyal service may even serve the important social purpose of preventing masters from hiring away each others' trained workers; a divisive practice which helped to weaken the apprenticeship system in Western Europe.[76]

Balancing Training and Production. The African craft workshop, like its medieval European predecessors, must harmonize two distinct and seemingly antagonistic functions: 1) production of goods and services, and 2) training of apprentices. The delicacy as well as the importance of holding these two ideals in balance is best seen by describing what happens when one is emphasized at the expense of the other.

A preoccupation with production tends to organize labor only for the purpose of maximizing output and quality control. The prime consideration in allocating tasks becomes one of extracting the most from the available skills of the labor force. A worker who has achieved competence at a particular routine--for example, a mechanic who is good at repairing carburetors, a tailor at sewing shirts, a carpenter at pattern-making--is best utilized by assigning him that task. Optimal use will be made of his productivity because he can do the job better than anyone else. The consequence of this concentration on one job, however, is the development of a narrow specialist rather than a comprehensive craftsman. Such a worker is indeed an expert within his limited repertoire of skills, but is shortchanged in his exposure to the full range of activity in his trade.

Sometimes a narrow specialty becomes a legitimate trade in its own right, as in the case of the tin lampmaker of Kenya who produces one small, simply-constructed item for a living.[77] In the course of his training an apprentice learns only the few manipulative skills needed to make his lamps. Within as little as three months time he may be fully competent in his trade and can begin turning out tin lamps for his own sale. Clearly, the problems stemming from an overemphasis on production hardly apply here since the trainee is not hindered from learning any major facet of the trade.

Another group of Kenyan artisans exemplifies a more overt bias toward production. These innovative entrepreneurs have designed and built simple, hand-operated machines for the manufacture of several non-traditional metal products on a small scale. Their need for workers to operate the machines has left them with little interest in training apprentices in the art of machine-making. King quotes the rationale of one artisan who refuses to accept apprentices on a formal basis:

> If I take on somebody, I will want him to do the heavy, dirty work--drilling lots and lots of holes with the hand-brace; so if the father has given me four hundred shillings to teach his son, the boy will soon complain that he is not learning anything.[78]

Evidently, to fully exploit the advantage of his machines, a master must employ workers who will do nothing but repeat the same sequence of steps over and over. Any skills that such a worker might acquire beyond what is required of him as a machine operator will have to be picked up unofficially through his own efforts.

Emphasizing training at the other end of the continuum (as in the garage school above) would sacrifice production to create an environment more responsive to the needs of trainees. Trainees would move around from job to job, mastering every aspect of the trade in an orderly sequence. While this would be a just and systematic way to learning technical skills, such exclusive emphasis on training may be detrimental in another sense. A trainee who expects to market his skills to the public must know what it is like to practice his craft as as a real artisan in a functioning workshop--not in some garage school that may be far removed from actual working conditions. When it comes to running a business, textbook exercises and a carefully crafted curriculum are no substitute for the first-hand experience of meeting production deadlines, solving obstinate technical problems, or pleasing irate customers.

The most equitable arrangement for both apprentices and masters seems to be maintaining a rough equilibrium between production and training. In this case a master would be entitled to organize his workers as efficiently as he could while observing a reasonable respect for their rights as learners. Actually, the problem of striking a proper balance between production and training may be resolved by the almost tautological relationship of the two functions in the small workshop. That is, training requires access to work. But reliable performance of the work demands that a worker have the necessary skills, implying, of course, the existence of some mechanism to transmit those skills. It would be only where training and production fail to intersect that the analysis of possible exploitation should begin.

Yet, even instances of apparent exploitation of apprentices can be deceiving. A journeyman in one of the wayside mechanics workshops that the author frequented became upset by the incessant errands he was sent on to purchase spare parts. He complained privately that such journeys took him away from needed practice in the workshop and contributed nothing to his understanding of mechanics. But these same assignments for which he alone was selected afforded him the luxury of following up on employment leads--of which one subsequently paid off with a mechanics job in a large automotive firm!

Summary

This chapter has taken a rather broad view of informal sector training in Africa, of which the apprenticeship system in the small craft workshops of West Africa is a part. A number of factors both internal and external to the small workshop have been identified and their influence on the operation of the apprenticeship system assessed. The specific effects of some of these factors will become more apparent as the study now turns to an intensive examination of one particular apprenticeship system in Ghana.

FOOTNOTES--CHAPTER II

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[14] Udy, op. cit., pp. 65-66.

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[72] Callaway, "Nigeria's Indigenous Education," p. 73.

[73] King, *The African Artisan*, p. 50.

[74] Smutylo, op. cit., pp. 180-81.

[75] King, *The African Artisan*, p. 51.

[76] Paul H. Douglas, "Apprenticeship," *Encyclopedia of the Social Sciences*, I (New York: MacMillan, 1930), 146.

[77] King, *The African Artisan*, pp. 149-50.

[78] King, *The African Artisan*, pp. 174-75.

CHAPTER III

THE WAYSIDE MECHANICS WORKSHOPS OF KOFORIDUA

Chapter II traced the historical development of the small craft workshop in West Africa and surveyed some of the major issues that have been raised in regard to informal skill training in Africa. From this broad perspective the study now proceeds to examine informal skill training in the wayside mechanics workshops of Ghana. Chapter III begins by providing a general profile of the wayside mechanics workshops and the conditions under which the apprenticeship system operates within them. The first part of the chapter describes the nature and role of the wayside mechanics in West Africa and, more specifically, in Koforidua, Ghana, where the study was conducted. The organization of the workshops, their typical layout and physical facilities, the personnel who operate them and the type of tools and equipment with which they work are among the topics which are discussed in these sections.

The second part of the chapter describes the general characteristics of the apprenticeship system in the wayside mechanics workshops. Among the topics covered in this discussion are the mechanisms by which apprentices and masters "find" each other; the formalization of the apprenticeship agreement; the ethnic background, education, previous experience, and motivations of apprentices; the relationship of apprentices to their masters; a typical workday, and financial considerations of the apprenticeships. Following this, several case studies of individual apprentice and master mechanics are presented to provide personal vignettes of real artisans. Because the discussion is intended to focus only on the general setting and operation of the apprenticeship system, issues relating specifically to the skill learning process are omitted since they are discussed in Chapter IV.

The Important Role of Wayside Mechanics

Throughout Anglophone West Africa, much of the maintenance and repair of motor vehicles is done in small private garages known commonly as wayside mechanics (or wayside fitting) workshops. These workshops take their name and derive their business from their convenient location along the waysides of village, town and city streets across West African communities. Together with the artisans who operate them, the wayside mechanics workshops constitute one of the many components of what was loosely referred to in Chapter II as the informal sector of the economy.

Wayside mechanics have carved out an important niche for themselves both in Ghana and elsewhere in West Africa. They play a large part in maintaining many of the country's vehicles in running condition, enabling them to continue transporting people and commodities against a background of rapidly escalating transportation needs. Their success in keeping these vehicles on the road is impressive in that it is accomplished in the face of sometimes desperate shortages of spare parts and lack of adequate tools--conditions that frequently require a considerable degree of improvisational ability on their part.

The number of these workshops varies greatly depending on the size of the community. A village may have a single crudely-equipped workshop while a large city such as Accra or Kumasi may have many hundreds of workshops varying in size and sophistication. In most communities the workshops are situated wherever a suitable vacant lot can be found or the competition appears to be lower. In two cities, Accra and Kumasi, many of the wayside workshops are located on a common site within the city limits where the various support services can be concentrated and the unsightliness of dispersed workshops minimized. This centralization of workshops in one location was brought about through the insistence of local governmental authorities. There seems to be a continued movement in this direction in other cities, including Koforidua, with proposals to relocate workshops on common sites in industrial parks on the edge of town.

The wayside fitting workshops often co-exist with several large commercial firms, mostly of multi-national ownership, which have automotive sales and repair divisions. These firms also perform a considerable amount of repair service for the country. Because they are usually well-equipped and have easy access to spare parts, the large workshops have a reputation for doing quality and prompt repairs. However, it is the wayside mechanics who are known for doing the same repairs far more cheaply and who are willing to carry their services to the smaller towns and villages where large firms are unwilling to locate. Thus, wayside mechanics provide a viable and functionally important service to many parts of present-day West Africa.

Koforidua and Its Wayside Mechanics Workshops

Koforidua is a medium size city in southern Ghana with a population of around 45,000. Situated about fifty-five miles north of Accra, Koforidua is the capital of the Eastern Region of Ghana, with regional offices of the various ministries and departments located there. Commercially, Koforidua is also a city of some importance, especially as a collection center for the highly profitable cocoa farming industry. In addition to numerous small businesses, several of the large foreign-owned firms operating in Ghana have branch shops and warehouses in Koforidua. However, in general these branch shops have only a small selection of the goods available in the main shops in Accra.

Koforidua is a growing city as well. A sizeable amount of new construction has been underway, both of commercial and Government buildings and private housing. As part of a large urban renewal project in Koforidua, a section of older, congested housing in the center of the city has been razed and construction of commercial buildings has begun in its place.

The city is also a transportation hub. The main Accra-Kumasi rail line passes through Koforidua making it a major freight and passenger stop. The State Transport Corporation maintains bus service several times a day from Koforidua to both Accra and Kumasi. Although it is not on the main Accra-Kumasi highway, Koforidua is a major link for several roads passing in all directions through the region. As a result, vehicular traffic, consisting of both cars and heavy tractortrailer trucks, is quite heavy in the city. Because of the volume of traffic, the town also serves as a major repair center for those vehicles.

As of 1977, there were thirty-nine wayside mechanics workshops within the city limits of Koforidua which repaired a variety of models of cars, trucks, motorcycles and other vehicles and machines. As in other Ghanaian cities, these workshops were scattered around the city. Some of the more established workshops run by older mechanics had occupied the same site for many years. New workshops beginning businesses in Koforidua were typically set up on the outskirts of town where plots of land were easier to obtain and where a new market might be tapped.

There was not always such a large number of workshops in Koforidua. One of the oldest active master fitters in Koforidua, who first came in 1932, recalls that there were only five private wayside mechanics workshops at that time. There were also two large firms with mechanical workshops which employed a number of the present master fitters. It was not really until the post-World War II period when the large firms slowly began to pull out that the private workshops proliferated to take up the slack and meet the increasing demand for repair services.

Workshop Organization. The typical wayside workshop is comprised of more than fitters alone. Associated with them are several allied trades that perform other vehicle repair services: auto-electrical repair, electric and carbide welding, auto-body straightening, spray painting, blacksmithing, radiator repair and assorted other crafts such as upholstery repair. Nearly all wayside workshops have artisans representing two or more of these trades sharing the same workshop site.

This is done not only to share the rent for the plot among several persons, but for the convenience of customers who may require the services of more than one tradesman. Appendix B gives a list of the wayside mechanics workshops in Koforidua along with a breakdown of the various trades that are practiced in each workshop. Though a workshop may contain several artisans practicing different trades, fitters generally are regarded by most artisans as the most important of the group.

Artisans practicing different trades usually run their businesses separately although they are of course sharing a common plot of land. Due to their close proximity, however, they often refer business requiring the work of different trades to each other. Although artisans of different trades may work separately, there is usually one artisan who is either older or has occupied the site longer than the others and that individual is often designated as the workshop head. While this does not imply any control on the part of the head over the other artisans operating on the site, it does mean that the head is probably the one who has leased the land for the workshop or who represents the other artisans in dealing with the landowner or government officials if the need should arise. He will also usually collect the other artisans' share of the rent and pay the landowner.

In addition to the master or group of master artisans, a wayside workshop usually has several other workers of varying degrees of rank, competence and experience who assist the master with the work. The number of such workers varies widely from workshop to workshop. Some workshops may have as few as one or two and others as many as twenty-five or more depending on the volume of business in the workshop and the master's ability to support them. There are two general classifications of such workers: 1) apprentices, who are in some stage of training, and 2) journeymen or seniors, who have completed their training and are working for their masters, usually for some nominal compensation. These workers are vital to the operation of the workshop and together represent the functional equivalent of the experienced and well-paid workshop assistant in a smaller private garage in the West. They perform the full range of jobs in the workshop from the most menial clean-up chores to the most sophisticated and complicated engine repairs. Generally, through the course of the master's career, the number of such workers increases to a maximum at the time his business peaks and then gradually falls again as his business declines and he nears retirement.

Specialization. Wayside mechanics are usually specialists in their trade. The vast majority of wayside mechanics in Koforidua specialize in particular makes (brands) or types (automobiles or trucks) of vehicles. Even if a wayside mechanic claims to be a general mechanic, most likely he works far more frequently on certain makes than on a broad range of vehicles. Some mechanics make the division between those they work on and those they do not on the basis of engine types; that is, some know how to repair diesel engines and others gasoline engines. If faced with the prospect of having to repair a vehicle they do not normally work on, most wayside mechanics refer the owner to a fellow artisan who does specialize in that make. This policy not only protects the mechanic's reputation by preventing a potentially disastrous attempt to make a repair, but also ultimately benefits him in business referred from his colleagues.

There are a number of reasons for such specialization and the absence of a general mechanic in the Western sense. In fact, there seems to be no Ghanaian equivalent to the "filling station" mechanic in the West who repairs any car that happens to come in. Service stations in Ghana sell gasoline and oil, but, except for the large stations in Accra, do not have bays and lifts where oil changes, lubrications, and extensive repairs can be made.

The specialization of Ghanaian wayside mechanics is, of course, directly related to their training. The masters who taught them worked only on certain makes of vehicles and they as apprentices learned their skills only on those makes. This pattern perhaps can be traced back to the earliest years that motor vehicles existed in Ghana, when the firms that imported vehicles would hire and train Ghanaian mechanics to work only on those makes imported by the company. Adding to this is the fact that in learning specific repair procedures for one make of vehicle, a mechanic was likely to feel more comfortable in repairing only that make and would often exploit his specialty by characterizing himself as an "expert" in the repair of that vehicle.

Physical Facilities. The physical facilities of the wayside mechanics workshops are often spartan. Some of the longer established workshops actually may occupy a permanent building of some sort, at least to store equipment and tools. But, more often, the typical wayside workshop consists of a temporary structure for tool storage made of either wood and a corrugated tin roof or entirely of corrugated tin. This structure is usually found at the side or the back of an open area where the vehicles are parked and repaired. Some of the less affluent mechanics may not have an enclosed structure of any kind other than a simple shelter made of corrugated tin and wooden posts to protect the mechanic and his apprentices from the sun and rain. The wayside workshops that operate under the least permanent conditions are popularly known as "mango tree" mechanics, owing to the fact that they practice their trade under a large shady mango tree.

Regardless of whether the workshop has a permanent tool storage structure, the actual repair work is carried on in the open air or under temporary enclosures. Generally, the delicate disassembly work of component engine parts is done on workbenches under the enclosures to protect the parts from exposure to rain. Vehicles that have more recently been brought in for repair are often parked alongside other vehicles that have been waiting long to be completed--perhaps never to be repaired. In some busy workshops or in ones with limited space, repairs sometimes spill out into the roadways. This situation plus the junked or abandoned vehicles and old chassis parts lying around the workshop sites has contributed to the widespread view among government authorities that wayside mechanics workshops are an eyesore that must be moved to less conspicuous locations.

Tools The tools with which wayside mechanics have to work also vary widely from workshop to workshop. While some of the larger workshops might have at least two or more sets of hand tools, all workshops would have at least one set each of most of the popular size wrenches. They might also have several homemade tools such as a punch or a socket wrench set with a few handmade sockets made by blacksmiths. One other popular handmade tool is a valve grinder, which is nothing more than a thin metal bar welded to a "T grip" handle which the apprentice rotates alternately clockwise and counter-clockwise until the valve is ground properly in its valve seat.

In general, however, wayside mechanics workshops are not well equipped with either enough sets of standard tools for the number of individuals working on different jobs or with a range of specialized tools and equipment that would allow a mechanic to undertake specific tasks easily and in a minimum of time. As a result of shortages of wrenches and other standard tools in the wayside workshops, workers must constantly pass around the limited tools which they do have. This often results in delays as workers wait for the tools necessary to complete the job.

The Apprenticeship System

Associated with all of the vehicle repair trades is an apprenticeship system which provides for the training of new craftsmen. In West Africa the apprenticeship system is the usual means by which the technical skills of the trade are passed on to trainees, both in non-traditional trades such as mechanics or electrical appliance repair and in such traditional crafts as carving, weaving and tailoring.

In the apprenticeship system of the wayside mechanics workshops, young Ghanaian men are inducted into the workshop for a more or less specified period of time, during which they expect to learn all of the skills of the trade and emerge at the end as full-fledged masters. While they are learning, they are expected to perform the regular work of the workshop as the master requests and in a manner that he finds acceptable. Their full participation in the work is both a partial compensation to the master for training them and also the mechanism by which they will learn the skills of the trade.

It is fair to say that apprenticeship training is a binding training experience. It is undertaken neither lightly nor informally. The conditions under which an apprentice enters into training with a particular master are clearly specified for the individual in a relatively formal way that resemble, to some extent, the earlier European craft guilds. Certainly the conditions are formal and specified to a degree much greater than the skill training arrangements among the informal sector artisans of East Africa. Yet, while formal in a special sense, the West African craft apprenticeship is a classic example of informal education.

Selecting a Workshop. Although apprentices, for one reason or another may be attracted to particular workshops for their apprenticeships, their deliberations in choosing a workshop are not influenced by any formal recruitment practices. In reality, masters make little effort to actively recruit young men as apprentices in their workshops. Instead they rely almost exclusively on word of mouth to inform prospective apprentices of the existence of the workshop and its availability to them as a training option.

Information about workshops and masters is passed through a variety of informal networks: kin relationships, shared ethnic or hometown origins and long-standing friendships or business acquaintances. An older brother who was once an apprentice with a particular master may direct his younger brother to that same master. A friend from the same hometown may recommend the master with whom he is apprenticing on one of his trips home. An uncle who is the friend of a master fitter may take his nephew to him as a candidate for apprenticeship after receiving a request from the father to find a workshop for his son. A car owner who frequently brings his car to a master for repair may bring his son for apprenticeship. These and many other complex interrelationships help explain how apprentices find their way to certain workshops.

Generally, it seems that masters have more than enough potential candidates for apprentices. One well known master in Koforidua, for example, reported that perhaps as many as twenty to thirty young men come to his workshop every year to apply as apprentices, out of which he usually accepts only four. In a situation where the master is so clearly favored, it is hardly surprising that many masters prefer to accept young men who have been brought to them personally or recommended by a relative or someone they know well rather than an unknown person off the streets. This preference for accepting only those individuals they know is an understandable bias. If an apprentice happens to steal tools from the workshop or parts from a customer's car or leaves before completing his apprenticeship, the master can more easily hold someone he knows accountable for the apprentice's behavior.

Whatever the particular association between the master and the prospective apprentice's family, the master may initially accept him into apprenticeship only on a trial basis. This trial period usually lasts only a few months. During that time, the master will assess the apprentice's seriousness, intelligence and the quality of his work. In addition to judging whether the apprentice is a good worker and can learn the trade well, he will also try to determine the moral character of the apprentice. Can he be trusted with the expensive tools in the workshops? Can he work carefully on expensive vehicles? The answers to these and other questions will form the basis of the master's decision on whether to formally accept the young man as an apprentice.

When he is ready to formally accept the young man as an apprentice (either when the young man first presents himself or after an initial trial period), the master will ask him to bring one of his parents or the adult who will assume responsibility for his apprenticeship. It is at the meeting of the two responsible parties--the master and the guarantor of the apprentice--that the specific terms and conditions of the apprenticeship will be discussed and agreed upon.

The Apprenticeship Agreement. The apprenticeships of the wayside mechanics workshops operate under a formal agreement between the master and the prospective apprentice's family which defines the conditions for the master's acceptance of him into training. This agreement is usually consummated in a written document (a sample of which is found in Appendix C) between the two parties in the presence of witnesses. These agreements are legal documents clearly specifying the responsible parties, the financial obligations of the apprentice's guarantor, the behavioral requirments of the apprentice and the master's responsibilities to the apprentice. Aside from saying that the master will be expected to train the apprentice to be a mechanic, nothing is said about the exact nature of that training and the specific skills and knowledge that the apprentice is to acquire. It is thus left to the individual master's judgement to determine what and how the apprentice will learn and also to decide when the apprentice has in fact gained the competence to be released from training.

There are, of course, variations in the types of apprenticeship arrangements undertaken which are reflected in the written agreements. Smutylo,[1] in his study of wayside artisans in Accra, identified two distinct types of arrangements that he believes differ only in degree. These are the fostering apprenticeship and the vocational apprenticeship. The fostering type, the less common but more basic of the two, often occurs between kin relatives--that is, the master being related to the family of the apprentice. The fostering type is typified by very little or no cash payment being required for the training, a relatively long apprenticeship period, the induction of the boy into the apprenticeship at an early age (late childhood or early teens) and the master assuming complete responsibility for the care as well as the training of the apprentice. The vocational apprenticeship, by contrast, calls for a shorter apprenticeship beginning at a later age (usually fourteen to eighteen) with the master assuming responsibility only for the training and demanding a substantial cash payment in exchange for that training.

The tuition fees paid by an apprentice and his family can vary considerably, depending on when he enters the apprenticeship, whether or not he is provided board or lodging by the master and whether or not he and his family are related to or close friends with the master. Nonboarding apprentices (or "day apprentices", as some masters call them) who began their apprenticeships in the early 1970's often paid around ₵ 90 in tuition fees for their entire apprenticeship training, while those entering within the past four years pay at least ₵ 150 or more.[2] For a boarder, the tuition might now be as much as ₵ 350 for the three years. The rise in the tuition charges reflects the general inflationary trends in Ghana today, which has been one of the highest in Africa.

The apprentice and his guarantor are normally expected to make an initial payment at the time when the apprenticeship agreement is signed and the apprentice is formally inducted into training. The balance of the tuition is either paid in yearly installments with the final payment at the time of completion or in one lump sum at the time of completion. At the time the initial payment is made, the apprentice may also be expected to pay a small sum (₵ 5 to ₵ 10) to be divided among all the apprentices presently in the workshop. The purpose of such a payment, when it is made, may only be to impress upon the new apprentice that he has the least seniority of anyone in the workshop and is completely subordinate to those who have been there longer. In one workshop, an apprentice mentioned in an interview that he used to give the senior workers ₵ 2 a month to have them teach him the skills more quickly. In interviews with other apprentices in the workshop, it seemed that this same worker, now a journeyman with nearly six years experience in the workshop, is not particularly popular among the younger apprentices because of his apparent insistence on being given money before he will explain a repair procedure to them.

Making the necessary payments to the master is sometimes difficult for some parents, especially those who may have to rely on another family member to assume the payments for them. For parents who have had to terminate their son's schooling for lack of money to pay the school fees, the apprenticeship fees may come as only slightly less burdensome. One apprentice explains the rather tortuous route he took to finally collect enough money to cover his apprenticeship fees.

> When I finished my Form IV in school in 1971, I wrote to my elder brother telling him that fitting is the work I would like to do. He told me that he agreed but that I should wait for financial help. I waited for two years--no help came. I was about to change my mind and apply for work at the Cocoa Research Unit, but found out the position was filled. So I went to see my brother again and he told me not to worry and that he would help me. In early 1974, he sent £ 30 to my father and told him to add some money to it to make £ 50. Instead, my father 'chopped' the money and I became worried. I told my mother that if I didn't get a trade now I would go anywhere I like. Immediately my mother saw I was much concerned about the work so she went to my uncle at Kibi and collected £ 40 and added £ 10 to it for my first year agreement fee. Then I came to start my apprenticeship.[3]

The master, too, has responsibilities towards the apprentice and his family. He must insure that the apprentice learns the skills of the trade within the time agreed upon by the two parties and then agree to release the apprentice from his training. At the time of completion and after all the other obligations of the agreement have been satisfied, the master is expected to prepare a testimonial for the apprentice indicating that he is well qualified in the eyes of the master.

The master has some financial and custodial responsibilities to apprentices as well. If he has taken in a fostering type or boarding apprentice, the master must provide for all of his basic needs: his meals, a place to stay and in some cases other necessities such as clothing and hospital care. Here, then, the master is playing a role somewhat akin to a surrogate parent for the apprentice. In addition to providing these necessities, he may also regulate the behavior of the apprentice in much the same way that the apprentice's own parents might do. For a non-boarding apprentice, however, the master may only be expected to furnish the midday meal. This obligation most masters fulfill by giving the apprentice 20 to 40 Pesewas a day in "chop money" (money for food).

There is a small ceremony marking the occasion when the apprentice begins his apprenticeship and a more elaborate one when he finally completes it. In addition to the cash payments that the apprentice and his guarantor make at that time, it is also customary for them to bring several other items for the master such as a bottle of schnapps or whiskey, several bottles of beer, food, cigarettes, matches and sometimes a sheep at the completion ceremony. The food and drinks are used to entertain the various guests at the ceremony, including relatives of the apprentice and associates of the master who may be taking part in the proceedings.

The purpose of these ceremonies is to impress upon the apprentice the seriousness of the step he is about to take, whether he is entering the workshop to begin his training or leaving it to pursue his fortunes as a master artisan in his own right. Divine Providence is summoned through a pouring of libation. In the entering ceremony, God's help is asked to enable the apprentice to learn the work well and, in the leaving ceremony, his protection for the apprentice in going out.

Not all masters conduct such ceremonies, though, and some may have only abbreviated versions or merely give the apprentice some advice. One master, who worked for some years as a mechanic in a European-owned firm, believes that ceremonies are "worthless" and asks that parents supply the apprentice with a few small tools instead of bringing him drinks and cigarettes. He claims that all of his rules are based on those from the firm where he worked. As he puts it, "If a European becomes an engineer, he doesn't have to buy a goat and he's still an engineer." His view, however, is undoubtedly the exception rather than the rule.

That the entering and completion ceremonies do make some kind of lasting impression on the apprentices who go through them seems undeniable. In nearly every case of the apprentices who were interviewed, the exact date of beginning and--in the cases of those who have passed through it--completing the apprenticeship were easily remembered.

The length of the apprenticeship period may vary slightly, but it is generally between three and three and a half years. During the course of the apprenticeship, an apprentice will usually expect to officially complete the obligations of his apprenticeship agreement on precisely the same day three years after entering the workshop. Although this may happen in some cases, normally because of a variety of factors--not the least of which is getting the money together for the final installment payment--the actual completion date may be delayed a few months.

After the completion of his apprenticeship, it is customary for the former apprentice to stay in the workshop and work for the master as a paid journeyman or "senior", as they are commonly called in the workshop. This additional period of work in the workshop is considered necessary for two reasons: 1) to express the former apprentice's appreciation to the master for training him and 2) to pick up additional experience in dealing with the vast range of repair problems that a fitter faces on a daily basis. This period is also the time when the young journeyman is often given greater responsibilities and learns new things: among them, for example, business matters and customer relations, supervision of younger apprentices and the responsibilities of purchasing spare parts for the master in Accra and Kumasi.

Many apprentices assume that they will not work for their master longer than six months or a year after completion of their apprenticeship before striking out on their own. However, the unanticipated difficulties of establishing a workshop for oneself or finding a job in a firm or with a mechanical workshop in one of the government ministries usually precludes any quick departure. In reality, journeymen often remain with their masters two or more years beyond their official apprenticeship. Two journeymen who were interviewed had begun their apprenticeships in 1970 and had continued working in the same workshop for nearly seven years before one finally left in early 1977 to take a job as a mechanic in a government workshop.

Background of Apprentices

It is difficult to give an exact profile of a typical wayside mechanics apprentice without conducting an extensive survey. However, some general features of apprentices' backgrounds can be identified from the data that were collected on a cross-section of apprentices in Koforidua. This information was obtained through intensive interviews of 48 apprentices, representing approximately one-sixth of the 300 apprentices who were attached to the 57 master (or clusters of masters) mechanics practicing in Koforidua. All but a very few of these apprentices came from 4 workshops that seemed to be representative of all wayside mechanics workshops in Koforidua in terms of their size, volume of business and age and education of their masters.

The general features that are drawn from this interview information can be grouped according to several categories: 1) the apprentice's ethnic identity; 2) his level of education; 3) the age of entering an apprenticeship; 4) the motivations for entering the trade, and 5) his previous work experience. Since an apprentice's ethnic origin is one of his most obvious identity labels, it is discussed first.

Ethnic Identity. Out of the 48 apprentices who were interviewed during the study, 23 (48 per cent) were Ewes, 19 (40 per cent) were different sub-groups of Akans, 2 (4 per cent) were Krobos and the other four were single representatives of small minority groups from different parts of Ghana. Although, admittedly, a vast majority of the sample of apprentices interviewed were from only four workshops in Koforidua, these figures still indicate a major dominance of the fitting trade by Ewes. That Koforidua is located in an Akan-speaking area to which Ewes must migrate considerable distance makes the effect even more apparent. The results also conform with Smutylo's data on craft workshops in Accra, where he found a very heavy preponderance of Ewes in the fitting and carpentry trades (60 per cent and 85 per cent respectively).[4]

It is not immediately obvious why Ewes should dominate the fitting trade in Ghana. Szutylo offers several possible explanations for the Ewe dominance which he has apparently learned from discussions with Ewe artisans: 1) that Ewes have certain traits such as humility and the ability to do hard work which are required in such highly physical trades like fitting and carpentry; 2) that the early German missionaries who came to the Volta Region, where the bulk of Ewes live, emphasized technical training; 3) that Ewes gravitate towards trades like fitting where there are many employment opportunities for journeymen; 4) and that Ewes excel at trades where personal effort rather than education and financial capacity are the prerequisites of success.[5] To these factors one might add the widely held belief that the land suitable for cultivation in the Volta Region is no longer adequate for the expanding population there, forcing many young men to look for alternatives to farming for earning their livelihood.

Educational Level. On the question of educational level of apprentices, 35 out of the 48 apprentices interviewed (73 per cent) had completed Form IV of middle school while another seven had completed a few years of primary school. Two other part-time apprentices were attending technical secondary school where they were studying motor mechanics theory in the classroom and doing their practicals in the wayside mechanics workshops. Only one apprentice interviewed had never attended school. These results seem to support Smutylo's data, in which 76 per cent of his total sample of 125 workers from several different types of workshops had either attended or completed middle school.[6]

Apprentices were also generally literate in more than one language and were often able to speak three or more languages. Apprentices who had been to school for at least several years were usually literate in English and their own mother tongue. In the first few years of primary school in Ghana, the local vernacular is used as the medium of instruction and is the basis on which literacy is first introduced. English is then phased into the instruction in the later years of primary school. The additional spoken languages are often picked up when the student attends school in a different language area, when one of his parents or close relatives is from a different tribal group or when he joins a workshop with a master or fellow apprentices who speak a different language. The latter is a common occurrence since many workshops have a varied ethnic make-up. If the master or the seniors do not speak the apprentice's language he will be required to learn their's since they will be giving the instructions. Interestingly enough, there are occasionally apprentices who do not speak any language spoken by most of the workers in the workshop and must fend for themselves until such time that they can communicate adequately. A young apprentice in one of the workshops came from northern Ghana and speaks only Hausa. Apparently he was able to function adequately only because one of the other apprentices could translate the instructions from the seniors into a language intelligible to both of them.

Although the specific educational data are not available for a large number of masters in Koforidua, the level of education typical of wayside fitting apprentices would seem to make them a somewhat better formally educated group than their own masters. Among the four workshops that were studied intensively, only one had a master who had as much or more formal education than most of his apprentices. Indeed, there are a number of cases where the master was illiterate and unschooled but his apprentices were literate and schooled. Although this discrepancy could potentially cause difficulties in the relations between masters and apprentices, it appears not to have had that effect. While masters and apprentices may be well aware of the differences in the levels of their education, any feelings of inferiority or superiority are rarely manifested in any overt behavior by either masters or apprentices. In the minds of most fitters, motor mechanics is a practical set of skills for which formal schooling has little bearing on one's ability to learn. One widely respected fitter in Koforidua takes great pride in the fact that he has trained a number of school learners to become mechanics during his career, even though he himself is illiterate and has never attended school.

Completion of Form IV of middle school would appear to be a kind of educational watershed for many would-be apprentices. The fact that Form IV is a common stopping point in the formal schooling of many apprentices seems to satisfy their need (or their family's need) for some formal education. At the same time, exposure to this amount of formal education apparently does not alter their willingness to accept another line of training other than completion of secondary school.

Although the lack of money for school fees was often the major reason for not going on to secondary school, most apprentices seemed perfectly happy to drop out of school at that point and pursue a more practical training experience. In fact, in some cases the young man himself, rather than the parents, was the one to express dissatisfaction with school and inform his parents that he wished to learn a trade. In only a very few cases did an apprentice indicate that his apprentice training was a choice of last resort and that he would have preferred to continue in school if possible.

Age of training. Like the educational level, the age at which young men embark upon apprenticeship training seems to vary widely. In the Koforidua sample, apprentices began their apprenticeships as young as 13 years of age and as old as 23 years. Of the 47 apprentices and 3 masters for which these data were collected, 28 (56 per cent) of them entered between the ages of 18 to 20 years; 37 (74 per cent) of them entered between 17 to 21 years. The average age of apprentices at the time of the study was 20.5 years, while that of journeymen was 22.5 years. Age information on masters was not collected.

The average age of apprentices in the Koforidua study seems to agree with Smutylo's figures, where the average age was 20 years.[7] However, the average age of Smutylo's journeymen was 28 years, making the Koforidua group somewhat younger. This difference is probably explained by the fact that the journeyman group in the Koforidua study was somewhat small (13) and included a few young former apprentices who had just completed their apprenticeships. While these young journeymen may not have been receiving pay from their masters for their work nor have yet assumed the full role of a journeyman, they were, technically speaking, no longer apprentices and could not be classified as such.

Possibly the most obvious fact to be gleaned from these figures is the gap of approximately 2 to 4 years between the age when many apprentices completed their schooling (approximately 16 years of age for Form IV leavers) and the age when they first entered their apprenticeships. This period was long enough to have permitted other work or training experiences but also, no doubt, a considerable amount of introspection about future plans. Since apprentices did not just leap into the study of mechanics after leaving school, they apparently needed time to make up their minds and to get the financial resources together before taking such a step.

Motivation for training. There are many reasons why young men choose to become apprentice mechanics. Not the least of these motivations is the realization that apprenticeship training is an acceptable alternative to formal schooling. While in earlier years it would have been relatively easy for a middle school leaver to secure a clerical job in the civil service or a private firm, today's employment conditions have changed. With an increasingly high unemployment rate among even secondary school leavers in Ghana, this option is virtually closed to all but a few exceptional middle school leavers. The reality of the employment situation in Ghana, as in many other African nations, has become openly apparent to many young people. With only the prospects of helping their parents with the family farm or migrating to the cities to join the ranks of thousands of other young unemployed, the alternative they once would have avoided now seems almost attractive.

While some see fitting work as little more than a respectable profession in a difficult economic situation, others have always had a genuine interest in becoming fitters. Some apprentices and masters report that they first became interested in mechanics work when they saw a fitter at work, perhaps when visiting a wayside workshop as a child or when a fitter came to the aid of a disabled vehicle in which they had been riding. Of particular interest is the fascination some apprentices apparently had for mechanical toys as children. Although no attempt has been made to correlate experience with mechanical toys with a strong desire to become a mechanic, it seems apparent that sometime in their childhood more than a few apprentices have either played with or actually built some of the uniquely designed homemade toys with which Ghanaian children are often seen playing.

An apprentice who was one of two apprentices studying mechanics formally in technical secondary school claimed that he first became interested in mechanics through reading about cars in school and in washing and tinkering with his father's car. He began to make some small repairs on his father's car after some success at repairing watches and small motors. Since he was also talented in art at school, he sometimes tried his hand at making sketches of various automobile designs. In fact, he hopes someday to study automotive design at a technical college after completion of secondary school. Indeed, his interest in the field of mechanics was so intense that he became a valuable informant and part-time research assistant for the author.

Sometimes apprentices see their training as simply a stepping stone to another profession. The motor vehicle has an almost irresistable grip on many youth in Ghana, particularly on those living in rural areas. The automobile and the truck, the sole means of transporting goods and people in and out of many villages, is perhaps the most visible symbol of modern technology to the residents of these villages. The motor vehicle is also the means by which one escapes from the village to the more alluring life of the large towns and cities. To a village youth, driving has the aura of a romantic profession, promising new experiences, new places to see, as well as giving command of a machine of awesome power and authority. Some young men live out this fascination with the motor vehicle by serving as drivers' mates, stealing chances whenever possible to practice their driving and hoping eventually to become a driver themselves. Others choose the fitting trade to gain the necessary entrance to the world of motor vehicles. By becoming a mechanic, they know they will always be intimately involved with motor vehicles and perhaps be presented with an opportunity to drive or even own a vehicle of their own.

Some apprentices see mechanics training as the means of satisfying another career goal--their childhood dream of becoming an engineer. When asked about their motivations for entering the fitting trade, some apprentices said that they had always wanted to become engineers for as long as they could remember. Although few stated it explicitly, they somehow expected their training in mechanics to fulfill those deeper longings for engineering itself.

Engineering does indeed enjoy a special esteem in the minds of many mechanics in Ghana. At times, one can hear mechanics referring to themselves as "motor engineers" or "doctors of cars." Some may even go so far as to use those terms in the official business titles on their signboards. Although the source of the mystique surrounding engineering is difficult to trace, it can perhaps be attributed to the rather attractive managerial role of many engineers in Ghana or possibly to widely-publicized accounts of sophisticated engineering feats in developed societies. Whatever the specific causes, it is generally assumed that engineers work with complicated machines and equipment and, for many mechanics, this fact alone invites comparisons with their own work. However, the early termination of their formal schooling and the largely practical nature of their workshop training would seem to leave little chance that Ghanaian mechanics and their apprentices could ever make the transition from mechanics to engineering, at least in the conventional meaning of that term.

Occasionally, an apprentice may mistakenly choose fitting as his life work. One apprentice who did make this mistake apparently found the physical demands of the work too arduous. He admitted frankly that he plans to become an apprentice in radio and television repairs after completing his fitting apprenticeship the following year. Other apprentices who might have found the work similarly unappealing, however, were more apt to resign themselves to their chosen trade than face the prospect of meeting the expenses and enduring the hardships of a second apprenticeship.

Previous Experience. It is instructive to look at what apprentices were doing before they became apprentices and what they thought they would be doing if they had not become fitting apprentices. Out of the 48 apprentices who were interviewed, 26 of them reported that they had been involved in some kind of work activity between the time they finished their schooling and the time they entered their apprenticeships. Some of these work experiences were actual paid jobs while others consisted simply of helping their parents on the family farm. However, since the question was phrased in such a way that it referred to paid employment, it is likely that many of the others who reported no previous work might have spent some time helping their parents with the faming. Among those who held some sort of paid employment, the work ranged over such diverse activities as fishing to photography to planting cocoa tress. It is difficult to conclude anything from this information about any possible relationship between previous work and the desire to become a fitter. In a few cases, however, it did seem that apprentices were first introduced to sophisticated machines through their employment as machine operators in factories or as mechanic assistants in construction companies.

On the question of what apprentices thought they would be doing had they not chosen to become apprentice mechanics, 20 of the 48 apprentices interviewed said they would probably have become farmers. Ten said they would have been drivers if they could not have been fitters and 9 said they would have taken up another trade such as carpentry, welding or tailoring. Five insisted that they would only have done fitting and a few apprentices said they would have continued their schooling or learned a trade which obviously required some additional formal training--e.g. drafting or automotive design.

Many of the apprentices' projections of alternative professions were obviously based on the assumption that continuation of their formal schooling was impossible, even if they had wanted to continue it. Indeed, as many as 21 out of the 48 apprentices indicated that they were unable to continue their schooling because their family lacked the money to pay the school fees any longer. Moreover, the statement of so many apprentices that they could picture themselves only as farmers if apprenticeship training had been closed off to them suggests that they were not left with a wide variety of vocational options. This bleak prospect, coupled with the substantial expense of most apprenticeships, undoubtedly helps to generate an intense motivation to successfully complete their apprenticeship training.

Now that the terms of the apprenticeship agreement have been spelled out and the backgrounds of apprentices described in detail, it is appropriate to take a closer look at how apprentices actually function in the real environment of the wayside mechanics workshop. The next section gives a brief sketch of what a typical day of work is like for an apprentice mechanic.

A Typical Workday

Work begins early in the wayside workshops. On business days, which are Monday through Saturday, apprentices usually arrive at the workshop sometime between 6 and 7 a.m. ready to accommodate the drivers who may bring their vehicles into the workshop beginning from daybreak.

During the first hour or two of the working day, the most recent apprentice (and possibly the next to the most recent apprentice) will have the responsibility to clean the workshop, fetch tools for the older apprentices who are beginning work and otherwise get things ready for the day's work. If there are jobs unfinished from the previous day, the apprentices who had been working on them before will probably pick up where they had left off. If a new repair job comes in early, the seniors will assign an apprentice or group of apprentices to attend to it if it is not a major job. By 7:30 or 8 o'clock the master will have arrived. At that time he will assess the work that is to be done and assign or re-assign apprentices and seniors to those jobs accordingly. He will also deal with customers whose vehicles require major repair work.

The intensity of the work, of course, depends almost entirely on the amount of business in the workshop. When there are many vehicles in the workshop that are actively being repaired, apprentices will be constantly busy, with little time for idle conversation or inactivity. If business is slow or if the vehicles under repair cannot be completed because of lack of spare parts, then apprentices may have long periods in which there is little or nothing to do. At such times, apprentices who have no work may watch other apprentices who are still working. Or they may simply sit around and relax, tell jokes and stories or ask questions of one another about the work. After a while, some may leave the workshop and drift into town, leaving only a few apprentices to handle any possible jobs that may come in. The master himself often does not remain in the workshop during these slow periods.

There is no specific time for the mid-day lunch break. Apprentices eat when they feel hungry or when they have finished a job or reached a point where it is convenient to stop work. Apprentices usually buy some snacks or other already prepared food commonly sold by roadside food vendors, while the master usually goes home for his lunch. In one small workshop, though, the master sends one of the apprentices to the market to buy some prepared food which he and his four apprentices eat together in the workshop.

The afternoon work period continues from the time apprentices return from their lunch break till the late afternoon, when things begin to wind down again. Around 5:30 p.m. the youngest apprentices will have begun to collect, clean and return the tools to the tools storage area. Apprentices may try to finish up any jobs that are close to completion, even if this means they will work into the evening. But, generally, by 6 p.m. work in the wayside fitting workshops has come to a close and apprentices are preparing for the evening.

After work, apprentices return to their places of residence, which is either the master's house, a relative's house, a room provided by the apprentice's family or the workshop itself. Apprentices change out of their work clothes, take their baths and prepare for dinner. If they are boarding apprentices, they will eat their dinner at the master's house. Already one or more of the younger apprentices would have been assigned in the afternoon to help the master's wife prepare the food for the dinner. By 8 o'clock they will be finished with dinner and back in their rooms.

The rest of the evening will be spent playing board games with fellow apprentices, reading a mechanics book they may own or just talking with fellow apprentices. Some may use the time to recapitulate the day's work and ask questions of the seniors about particular jobs or repair procedures. Apprentices occasionally wander into town at night to attend the cinema or see what is happening at the local music spots. These visits are infrequent, however, partly because apprentices usually do not have the money to go to the cinema and partly because many masters frown on such night activities. Apprentices generally go to bed as early as 9 p.m., due in no small part to the fact that the work is often physically difficult and that they must get up to begin work again early the next morning. One could safely conclude that the life of the average apprentice is quite austere indeed.

On Sundays there is some relief from the usual strict routine of the work week. Apprentices use Sundays as an opportunity to wash their clothes, go to church, visit friends or do any other things that they would like to do. Among the lattor are the informal repair jobs that the apprentice may have managed to arrange through contacts with drivers in his master's workshop. These so-called "corner jobs," as they are known in local parlance, are sometimes undertaken by an apprentice on his own time if he has a few tools of his own and can find a place to work on the vehicles away from the master's notice. While such "moonlighting" work is often discouraged by masters since it takes business away from their own workshops, it does allow some of the more advanced apprentices the opportunity to make a little additional money and to begin establishing some relationships with drivers who might well become part of their own future clientele.

However, the weekends may not be entirely free for the apprentices to pursue their own activities. The master may expect apprentices to assist with a variety of weekend jobs. For example, some of the younger apprentices will be assigned to wash and iron the masters working clothes. The master may also have vehicles of his own and he may expect his apprentices--at least those who do not attend church--to report to the workshop on Sundays to do any necessary maintenance or repair work. Or he may have some land which he actively farms and may ask his apprentices to go to the farm and help with the work on weekends. So, while Sundays are in principle a day when apprentices should be free of the obligations of their apprenticeships, in practice their freedom of activity even then is likely to be limited, especially if they are boarding apprentices.

Master-Apprentice Relations

It is probably an understatement to say that the relationship between a master and an apprentice can best be characterized as one of strict control of the apprentice's behavior and activities. The moment a young man enters the workshop to join the ranks of the apprentices, he comes under the influence of an unwritten code of behavior to which he will be subject for the duration of his stay in the workshop. If the apprentice is a boarder, the control of his movements and behavior is not limited to the working day, but extends into the non-working part of his life as well. In signing a formal agreement with the master to train their son, the parents in turn relinquish part of their role as parents to the master who, in effect, becomes a parent away from home.

One of the effects of such regimentation of behavior is a rather obvious social distance that exists between masters and apprentices. For example, there is seldom any apprentice-initiated social dialogue with masters. Masters and apprentices do not engage in casual conversation with each other unless the master initiates the discussion himself. This is not to say that masters and apprentices do not talk to one another. There is indeed a steady stream of dialogue between the master and his apprentices, but the vast bulk of it is work-related, directive, and one-way-- from master to apprentice.

The master also does not spend all of his time enforcing his rules of conduct and his standards of work in the workshop. Above all, it is a system into which apprentices are socialized and their expected behaviors are internalized to a large extent. In fact, it is the seniors who assume the brunt of enforcing the apprentice's behavior as it applies to the work since they will be held accountable by the master for the mistakes of the juniors with whom they work. Yet, when it comes to a confrontation there is no question of where the ultimate authority in the workshop lies. Rare is the apprentice who openly transgresses the rules or shows disrespect to the master with impunity.

In a sense, the special deference shown to the master by his apprentices is just a reflection of the familiar Ghanaian cultural trait of the respect of the young for those who are older. Yet, it seems to go beyond this. For the master, there is no substitute for the strict control he feels he must maintain over his workers. He is a private businessman and his success as a businessman has been built up by providing quality service to the customers he has carefully nurtured over the years. The mechanics trade is often a precarious one, characterized by keen competition among fitters for business and repairs involving expensive and hard-to-get spare parts. The mechanic can ill-afford a carefree atmosphere to exist in his workshop, which could conceivably lead to a costly act of negligence on the part of an apprentice and the tarnishing of his reputation as a mechanic.

In spite of the extensive monitoring of apprentices' work habits and demeanor, apprentices do on occasion make careless mistakes or are intentionally dishonest for their own personal gain--for example, in stealing parts from a customer's car and selling them later to someone else. When mistakes are made, the apprentice who committed the mistake is soundly reprimanded by the master and perhaps even suspended from the workshop for a period of time if the offense warrants. In cases of gross disregard of the rules of conduct or of personal dishonesty, the apprentice, if caught, may even be sacked entirely from the workshop and his guarantors held accountable for any loss suffered by the master.

Financial Considerations

Although the financial considerations related to the assistantship agreement have been mentioned earlier, it is worth discussing them in a more general sense here. As noted earlier, masters ordinarily give apprentices a small amount of "chop money" every day for their midday meal. This amount seems to range from 20 to 40 Pesewas a day in most workshops. With today's rate of inflation in Ghana, this sum is hardly sufficient to buy enough food for a hungry and hardworking young man. The apprentice must therefore supplement this amount either with money sent to him from home or from small tips or "dashes" given to him by drivers with whom he has become friendly. All of these sources together, however, are likely to provide only enough for a bare subsistence life-style for apprentices.

When the apprentice completes his apprenticeship, the case is somewhat different. He is technically a journeyman at this stage and is recognized and compensated as such by his master. In one large workshop with several seniors, for example, the master gives his junior apprentices 20 Pesewas a day in "chop money" and his seniors 40 Pesewas a day--not a substantial increase in compensation. In another large workshop with several seniors, the master begins paying the new senior ₵ 20 a month for the first two months he is a senior and ₵ 40 a month thereafter. In addition, he continues to provide the senior with a place to stay if he were originally a boarding apprentice.

All of this raises the controversial question of whether or not the whole apprenticeship system of wayside mechanics and other artisan trades is nothing but labor exploitation. To answer this question would require specific data on exactly how much money masters earn from their workshops in order to compare their income with the compensation they give to apprentices and journeymen who perform the bulk of the work in the workshop. However, this kind of data is very difficult to obtain since records are usually not kept and masters are reluctant to reveal their actual earnings. One master from a small workshop (2 apprentices) with a small to moderate clientele said that he makes about ₵ 40 a day on an average busy day but only ₵ 6 a day if business is slow. An apprentice in a large (20 apprentices) and busy workshop estimated that his master probably makes an average of ₵ 120 a day. The same apprentice, who is in his second year of apprenticeship, said his own earnings from tips averaged ₵ 2 a day.

Another way of determining a master's income is to estimate it by multiplying the labor charges for different kinds of repair jobs by the frequency of those repairs in the workshop. Such complete data were not collected for any workshop. However, it is possible to compare the charges in a few workshops for three sample repair jobs (see Table 11).[8] As one can see from the table, there is some variation in the charges for the same job from workshop to workshop. By far the most profitable repair job is the complete engine overhaul which appears to net the master anywhere from a few hundred to well over a thousand Cedis, depending on his labor charge. One overhaul a month may be done in a busy workshop such as the Akan Workshop, for example, while only three a year would be done in a small workshop like the Modern Motor Workshop. At this rate, the figures suggest that the Akan master would earn substantially more per year on engine overhauls than the Modern Motor master. Although engine overhauls do furnish considerable income, most masters probably rely on a host of smaller more common repair jobs for the bulk of their regular income.

TABLE 1

CHARGES FOR THREE REPAIR JOBS IN FOUR DIFFERENT WORKSHOPS*

Akan Workshop

1. General Maintenance--tightening nuts and bolts, minor adjustment, etc.		
	Total Charge	¢ 20.00
	Includes cost of any bolts replaced & ¢ 5 for apprentices	
2. Brake Overhaul		
	Labor for master	50.00
	Labor for appren.	5.00
3. Engine Overhaul		
	Parts	¢ 3250.00
	Labor (master)	1055.00
	Labor (appren)	55.00

Ayigbey Workshop

1. General Maintenance		¢ 10.00
2. Brake Overhaul		
	Parts	¢ 180.00
	Labor	20.00
3. Engine Overhaul		
	Total Charge--including parts and labor	¢ 8000.00

Note: one apprentice estimated that the master charged ¢ 400 for the labor for the engine overhaul.

Modern Motor Workshops

1. General Maintenance		
	Labor (master)	¢ 6.00
	Labor (appren)	1.00
2. Brake Overhaul rebuild wheel cylinders and adjust		
	Parts	¢ 27.00
	Labor	10.00
3. Engine Overhaul		
	Parts	¢ 3200.00
	Labor	150.00

Friendship Motor Workshop

1. General Maintenance		
	Labor only--not including bolts replaced	¢ 10.00
2. Brake Overhaul		
	Parts	¢ 64.00
	Labor	20.00
3. Engine Overhaul		
	Total Charge--includes parts and labor	¢ 3000.00

Note: parts for the overhaul estimated to be about ¢ 2820.00

*As of mid-1977.

In two of the workshops for which cost data were collected, the Akan Workshop and the Modern Motor Workshop, there seems to be a built-in system for collecting an apprentice labor charge from the customer on at least some jobs. However, this practice was not investigated to determine how much an individual apprentice actually receives from such charges once they are divided up among all the apprentices who worked on the job. It is also not known whether this is a consistent practice with all customers and for all jobs.

Apprentices themselves do not seem to feel that their apprenticeship experience is particularly exploitative. When questioned about their dislikes of the training, no apprentice complained directly or intimated that he was being used by the master to make an inordinate amount of money. Many were aware that their masters were financially successful, but all felt their own meager existence as apprentices was part of the struggle they had to endure to achieve similar success themselves.

It is therefore difficult to answer unequivocally the original question of labor exploitation. If one looks at the visible assets of fitters, it is obvious that some are very well off indeed and might conceivably pay some modest wages to their experienced workers (as some already do). Several of the more affluent fitters in Koforidua own houses, trucks, taxis as well as their own private cars. On the other hand, there are many other fitters who do not have any visible signs of wealth and seem to just be "getting by." The apprentices who put in the long hours of work that keep the masters in business often receive in return little more than a few coins for lunch money, a bed in the master's house and end up paying for it all anyway. Yet without the opportunity to be in a workshop and learn the work first-hand, few of these apprentices would ever be able to afford the alternative of learning mechanics in a technical school.

Case Studies of Master Mechanics and Apprentices in Koforidua

The following case studies provide a brief sketch of several wayside apprentices and masters who work in Koforidua. The accounts are intended to give a more personalized view of what wayside mechanics are like and the kind of work they do. The real names of the individuals in this section, as well as the names of other artisans cited throughout the study, have not been used in order to maintain their privacy.

Case #1--George Adumoka

Akan Workshop

> George Adumoka is a master mechanic and head of the Akan Workshop in Koforidua. He is a specialist in the repair of Mercedes-Benz vehicles and only works on cars and small buses of that make. Mr. Adumoka has a rather large workshop with eighteen apprentices but works alone as a master. He shares the same workshop site with several other artisans, including a group of Peugeot fitters, a welder, an auto-electrician, a paint sprayer. Of these, Adumoka's workshop is by far the most prominent.
>
> Adumoka is a relatively young mechanic at 37 years of age. He has been a master for 18 years since completing his apprenticeship in Kumasi in 1961. At 20 years of age, he surely was one of the youngest fitters to have opened his own workshop at that time in Kumasi.
>
> Adumoka was not always inclined to become a mechanic. In his early years in school, he recalls that he never thought of becoming a mechanic. It was his mother who first suspected that he might become a mechanic when she saw him collecting practical objects as an infant. In primary school Adumoka was interested only in learning and going as far as he could in school. In fact, for a good part of his school years, his main goal was to become a teacher. Only later in his middle schooling did he begin to think of becoming a mechanic.

He completed middle school in 1955 and, upon some encouragement from his father to take up mechanics, went on to attend Kumasi Polytechnic. There he studied motor mechanics for three years and received the London based City and Guilds Certificate in Mechanics after completing that course.

He then realized that if he were to become a practicing mechanic, he needed some practical experience to supplement his formal schooling. He became an apprentice with the State Transport Corporation where he worked for six months. He found on working at that job that he preferred to work for himself as an independent fitter. He wanted to have more contact with the drivers so he joined a workshop in Kumasi as an apprentice. He finally completed his apprenticeship in 1961 and took a job with one of the large automobile dealers in Ghana which imports and repairs Mercedes-Benx vehicles. It was during this job that he learned to work on all sorts of specialized mechanical equipment and tools. He also received his first Trade Certificate in Motor Mechanics from the National Vocational Training Institute after taking the trade test in 1961.

Adumoka's first workshop was in Kumasi which he operated from 1961 to 1964. During that time, several Benz bus drivers, who regularly plied the road from Kumasi to Koforidua, kept urging him to move his workshop to Koforidua since there were no competent Benz mechanics to repair their vehicles there. Finally convinced of the wisdom of such a move, he packed up and relocated his workshop in Koforidua in 1964 where he has been ever since.

Adumoka is a very careful and meticulous mechanic. He spares no effort to perform quality repair services with the minimum amount of expense to customers--although his labor charges are by no means inexpensive. His extensive formal technical education and work experience in large well-equipped workshops give him considerable knowledge of mechanical theory, with resulting benefits in tracing mechanical faults. He is acutely aware of his wide reputation as an excellent mechanic and goes to great lengths to protect his reputation. He performs delicate repair operations himself or supervises them closely when apprentices do the work. He is in the workshop every day, including Sundays, so as to be of service to drivers who require assistance. He often remarks that there is no vacation for mechanics--that they must take their vacations during slack periods in the workday. His systematic approach to his work even rubs off on his attire. Unlike some mechanics, he always presents a neat professional appearance in his clean blue work uniform, which seems to enhance his image of competence even more.

Adumoka is also a successful small businessman. One of his formulae for making additional income is to buy old Mercedes-Benz cars which are in need of repairs but still basically sound. He then completely restores the cars to their original condition and sells them for a profit. Since the Mercedes-Benz is a high status automobile in Ghana and has good resale value, he has done this successfully with several cars.

In dealing with his apprentices, Adumoka appears to be a traditionalist for the most part. He imposes the same obligations on and reflects the same kind of relationships with apprentices that are typical of other fitters. Yet, there are elements to his approach that are not altogether typical of most fitters. He seems to be uniformly well liked by his apprentices, who appreciate the fact that he is mild-mannered and does not shout at them when they make a mistake. He seems genuinely concerned that apprentices learn the work well and helps them work through any difficulties they may be having. He is also generous and sometimes gives unexpected bonuses to his apprentices on different occasions. He will also help an apprentice who is in financial need if the apprentice comes to him for assistance.

Adumoka is a member of the local artisans cooperative society, where he is one of the most respected members. Since he is so respected and is also one of a minority of artisans who can read and write well, he holds one of the important offices in the cooperative.

Case #2--Paul Daku Akan Workshop

Paul Daku is a senior or journeyman in the Akan Workshop. He is a twenty-five year old Ewe from the Volta Region of Ghana. Daku is now the second oldest worker in the workshop, having been an apprentice and senior for five years. As one of the oldest and most experienced workers, he commands a great deal of respect among the junior apprentices and is given major responsibilities by the master.

Daku first became interested in fitting work around the age of nine. At that time, he used to make and dismantle mechanical toys of various sorts. His father, who had once wanted to become a fitter, encouraged him to think of fitting. At the time he completed his middle school education, he saw many of his friends out of school but with no work. This convinced him that he would be better off learning a trade that would provide him with a steady job.

His first experience in mechanics, however, was not in a wayside mechanics workshop. He landed a job in the mechanical section of the construction company that was building the hydroelectric plant at Akosombo Dam. After working at this job for a year, he told his father he was ready to learn fitting in a wayside fitting workshop. His father, who was a driver for the Ministry of Agriculture, knew Mr. Adumoka from taking his vehicle to the Akan workshop for repair. With this connection between Daku's family and the master, his apprenticeship was soon arranged. He believes that if he had not been successful in entering a fitting apprenticeship he would have taken up welding.

Daku's apprenticeship seems to have been typical of most others. Since completing his apprenticeship and becoming a senior, he has become one of the trusted workers in the workshop. His master describes him as a very serious and quick-learning apprentice who is capable of performing any repair job in the workshop on this own. In the last year, he has assumed responsibility for going to Accra to purchase spare parts for the master. At the time of the study, he was negotiating with a manager of a new automobile firm in Accra for a possible job as a mechanic. If this job came through, he was planning to inform his master and leave the Akan Workshop for the new job.

Case #3--Kwesi Ayigbey Ayigbey Workshop

Kwesi Ayigbey is a master fitter specializing mainly in the repair of big diesel trucks as well as tractors and corn-milling machines. He works alone in a workshop which has no particular title except for its identity with his name. He shares a fairly large workshop site with several other artisans including two other truck fitters who work separately from each other, an auto-electrician, a welder and a blacksmith. He is an Ewe from the Volta Region of Ghana and is married with six children, five of whom are in school.

Ayigbey is one of the older fitters in Koforidua. He claims to be only forty-two years old, but appears to be older than this. He states that he began his apprenticeship at twelve years of age sometime before World War II and was still an apprentice at the time the war was over; a fact which would probably make him age fifty or more.

He is also completely illiterate, having never attended school. Even his spoken English is not very proficient and all interviews with him were conducted in one of the three Ghanaian languages he speaks (Ewe, Ga, and Twi) and subsequently translated by the author's research assistant. Yet, his illiteracy did not in any way hinder him from training to become a mechanic.

After completing his apprenticeship training in Koforidua after the war, Ayigbey left for Accra where he worked as a mechanic for the Union Trading Company (U.T.C.) for four years. U.T.C. is a large Swiss-owned company that imports and repairs foreign cars and trucks, among other things. When Leventis Company, another large importing firm, opened, he worked there as a mechanic for three years. It was during this working experience that he switched over from working on Dodge, Chevrolet, International and other American vehicles and began to work on diesel engines of all types. Although he undoubtedly learned much through these working experiences and even passed his first trade test at that time, he claims that he was never part of any in-service job training while working with the firms.

When he returned to Koforidua in the late 40's to establish his own workshop, there were only a few small wayside workshops and several large workshops associated with foreign-owned firms. Today, the situation is almost the reverse with a great proliferation of private workshops and no workshops of large firms in existence in Koforidua. Because of this dilution of repair business to a larger number of workshops, Ayigbey admits that his business today is less than what it once was in the early days.

In spite of the fact that he is illiterate and unschooled, Ayigbey is one of the most successful artisans in Koforidua. He has established for himself a formidable and enviable reputation as a mechanic. Apprentices have remarked that truck drivers from distant places in Ghana and even outside the country often bring their vehicles for him to repair, so widely-known is his reputation. When asked about the professional competence of their master, all of his apprentices uniformly agreed that, despite all of his other faults, he knows his craft exceptionally well.

Ayigbey is, like Adumoka, a very successful businessman. He owns houses, some farm land, trucks and a taxi, all of which provide additional income. Because of his success both professionally and as an entrepreneur, he represents something of a symbol to other artisans in town who have elected him to an important post in the local artisans cooperative.

At the moment, Ayigbey has about 20 apprentices. Many of them are either relatives (mostly nephews) or are from his home village, since he prefers to take in young men who are closely connected to him in some way. In terms of his relationships with his apprentices, he is quite traditional. He is a hard task-master when it comes to the quality of their work and has been known to shout severely at them or even throw tools when mistakes are made.

In recent years he has been incapacitated somewhat due to high blood pressure and is now under medication. As a result, he does not play as active a role in the workshop as he once did. Instead, he relies heavily on his workshop assistant, the most experienced senior, to run the workshop when he is not around. He does come into the workshop every day and stays for a few hours, while he deals with customers, delegates work to seniors and apprentices, and sends someone to buy spare parts in town or in Accra if necessary. Except to help apprentices with problems they have been unable to solve or to correct a mistake that has been made, he does not normally become actively involved in the work. One often sees him sitting on one of the benches in his workshop under the tall shade trees talking with various artisans and friends who pass through, but keeping a watchful eye, nevertheless, on the work of his apprentices out of the corner of his eye. His somewhat less active role in the workshop places much of the responsibility not only for the work but also of the instructional tasks in the hands of the older seniors.

Case #4--Peter Mensah

Peter Mensah is a twenty-four year old apprentice in the workshop of Kwesi Ayigbey. He is a son of ethnically mixed parents--one Dagbani and one Ewe--who spent much of his childhood in various towns in the Eastern Region of Ghana. However, he did spend enough time in northern Ghana where he spoke mostly Dagbani that he considers Salaga in the Northern Region to be his hometown and Dagbani as his first language. He is one of very few apprentices from the nothern part of Ghana in the wayside mechanics workshops of Koforidua.

Mensah first became interested in mechanics during his student years in middle school. He informed his father, a policeman, that he wanted to study fitting after completing his middle school education. His father encouraged him with the idea since the family was large and it was not likely that there would be money to send Mensah on to secondary school.

Mensah had a friend in Koforidua who was not a mechanic but rented a room in Ayigbey's house. The friend told Mensah about the good reputation of Ayigbey as a mechanic and Mensah, who was looking for a workshop in which to do his apprenticeship, came to meet him. Presumably, because he had enough apprentices at the time or because Mensah was not a relative or fellow townsman, Ayigbey asked him to wait three months before joining the workshop.

Mensah is now in the final stages of his apprenticeship, having completed more than three years. He seems to have genuinely enjoyed his apprenticeship training, saying that both his master and the seniors have helped him learn the work and treated him well. Like most apprentices who realize the internal dynamics of the workshop, he has been careful to respect and comply with the commands of the master and the older apprentices and seniors and is well-treated in return. He says that even the state of financial privation that most apprentices find themselves in does not really bother him, since his father regularly sends him money to supplement his meager daily allowance from the master.

His only reservation is his master's usual response to the occasional cases of petty theft in the workshop. Even if he knows the offender, his master apparently reprimands all of the apprentices as a group rather than singling out the individual involved. However, these minor annoyances do not affect his overall positive view of the apprenticeship experience. If he could do it over again, he would still choose to study mechanics in the wayside fitting workshop rather than study the trade in a technical institute or continue with his schooling.

His vocational goal after completing his apprenticeship and working for his master for a year is to find a job in a firm in Accra or the port city of Tema. He feels certain that his master will help him find such a job since the master knows many "big people" and has found jobs for others of his apprentices.

Case #5--Samuel Asumanu

Samuel Asumanu is a master fitter and head of the Modern Motor Workshop in Koforidua. He is a fifty-seven year old Akim, one of the tribal groups in the larger Akan grouping in Ghana. He is married with nine children, four of whom are in school and one of whom is one of his own apprentices. He is a likeable and gregarious man who is always ready to talk. Asumanu's workshop is quite a small one and perhaps in this way more typical of many wayside fitting workshops in Koforidua. He has five apprentices of his own. He shares the workshop only with one other artisan, a young Mercedes-Benz fitter with one apprentice, who recently completed his apprenticeship with George Adumoka. Asumanu advertizes that he specializes in Opel cars, although he claims to be a general fitter. From the types of cars one sees in his workshop, however, one could assume that he mainly works on Opels.

Unlike Adumoka and Ayigbey, Asumanu typifies the far less affluent wayside artisan struggling to make a good living at this trade. Although he is the same age as Ayigbey, he has apparently acquired few if any of the outward symbols of affluence such as houses, cars and trucks. The volume of business in his workshop is not great and one often sees only those vehicles for which he cannot get spare parts or even no vehicles at all in his workshop. The make of car he specializes in is one key to the situation. Opels are not one of the more common cars in Ghana and are not even being imported into Ghana in the numbers they once were. As Japanese and other imports gradually replace other cars, the number of Opels will slowly diminish, eroding his business even further.

Asumanu's training and background in mechanics, however, seem to belie the economic hardship he labors under. He attended school up to class 5 in primary school before dropping out, due, he says, to the fact that "his poor mother could not look after me in school again". He had always dreamed of doing fitting but had no one to help him. Finally, his father's younger brother, who was a fitter, asked him to learn fitting in his own workshop. He then began his apprenticeship in 1939 at the age of sixteen.

By 1943 he had completed his apprenticeship and had stayed on for a year to work with his master. During that same year, he joined the Gold Coast Colonial Army, in which he worked as a mechanic in India during the war. When he returned from his army service, he took up a mechanics job at the U.T.C. workshop if Koforidua. He worked there for nine years, five of them as a workshop assistant. He then opened his own workshop which he operated until the site on which the workshop was located was recalled by the landowner. He then decided to work once again for U.T.C. which had reopened their workshop, but soon left because of low wages. He then reopened his own fitting workshop at its present site five years ago.

Asumanu attributes his present lack of business to a shortage of adequate tools and equipment. Indeed, his workshop is starkly simple in appearance with only a small overhead shelter and no permanent tools storage. As a result, his tools must be carried to another place for safe storage every night. Like many other fitters, he is also beset by difficulties in locating spare parts to make his repairs.

Asumanu, like other small artisans in the wayside fitting trades, sees the local cooperative organization as a possible means of improving his lot. He favors a cooperative approach to purchases and distribution of spare parts, skills-upgrading, provision of services such as loans for workshop improvement or community-wide machine shop services. Frequently, he and others like him criticize the cooperative for not initiating the programs that would aid the less well-off artisans. But Asumanu, like some of the others, admits that he does not

> always show up for meetings and that he says little when he does attend.

Summary

This chapter has traced the general outlines of the apprenticeship system within the wayside mechanics workshops of Ghana. The role and organization of the wayside workshops as small repair businesses were described and several important areas relating to the operation of the apprenticeship system were discussed. Chapter IV will now discuss the major focus of the study--the nature of the skill learning process in the wayside mechanics workshops.

FOOTNOTES--CHAPTER III

[1] Terrence Smutylo, "Apprenticeship in the Wayside Workshops of an Accra Neighborhood," (unpublished M.A. thesis, University of Ghana, Legon, Ghana, 1973), pp. 81-86.

[2] One New Cedi (₵) is made up of 100 Pesewas and is equivalent to $2.75 at the current official exchange rate.

[3] Field interview, July 21, 1977.

[4] Smutylo, op. cit., p. 46.

[5] Ibid., pp. 46-47.

[6] Ibid., p. 49.

[7] Ibid., p. 41.

[8] The names of the workshops are changed to insure the privacy of their owners.

CHAPTER IV

SKILL ACQUISITION IN THE WAYSIDE MECHANICS WORKSHOP

Workshop Learning versus School Learning

One way to introduce a discussion of skill acquisition in the wayside mechanics workshop is to compare this indigenous training system with other kinds of learning experiences. While there are many comparisons that might be made, one of the more revealing ones is with the most familiar of all educational settings--the formal school. At first glance, one sees several striking similarities between the apprenticeship training system and the formal school. For example, both have their own unique learning environments: in the case of the school, it is the classroom; with the apprenticeship, the outdoor setting of the workshop itself. Inside both of these environments one finds "teachers" and "pupils" in one form or another who regularly engage in the dispensing or receiving of knowledge and skills. In both cases, too, there is a fairly well-defined body of knowledge and skills that is transmitted to learners in a relatively organized fashion.

While the wayside apprenticeship does resemble a kind of open-air school, it also differs in some respects from any formal school in Ghana or the West. Not the least of these differences centers around the respective subject matters of the two systems and the processes used in each to transmit its subject matter to learners. On the one hand, learning to become a mechanic in a wayside mechanics workshop involves the mastery of a substantial amount of technical knowledge, a task not unlike the learning of science or math in school. However, this knowledge is not learned in isolation from its concrete referents as much of school-based knowledge is learned. Nor is possession of the knowledge sufficient in itself to ensure success as a mechanic. Since mechanics are, above all, practicing artisans, they must also be competent in a host of complex practical skills. Most importantly, they must be able to intuitively blend these practical skills with the relevant technical knowledge to successfully carry out any repair operations they may encounter. It is this immediate and continuous application of one's knowledge and skill to everyday problems in the workshop that clearly distinguishes workshop learning from school learning.

The practical nature of mechanics training also requires quite a different mode of learning on the part of apprentices than is the case with school students. Instead of reading textbooks, listening to lectures or participating in classroom discussions, apprentices learn much of what they must know through observation and physical work--two essentially non-verbal, non-linguistic modes of learning. By observing the work of those who are more experienced, they gradually learn the rudiments of the profession and begin to participate directly in the work themselves. This observational learning mode is supplemented by regular directions and simple explanations from masters and seniors, which inform the apprentice of exactly what job he is to do and specifically how he is to go about doing it.

What follows is a more detailed analysis of this skills learning process, beginning with a look at how a young apprentice learns his first repair skills.

How Does One Learn in an Apprenticeship?

Unlike many of his American counterparts, the typical Ghanaian youth who undertakes mechanics training has had little or no personal experience in owning, repairing, or even driving a car by the time he begins his apprenticeship. Consequently, when he first arrives in the workshop, he is likely to be initially overwhelmed by the complexity of the work that goes on there and the immensity of the learning task that lies ahead of him. For many weeks and even months after entering he does exactly as he is told, performing simple unskilled chores that nearly every worker in the workshop has the right to assign him. Gradually, though, as he begins to feel more comfortable in his surroundings, tires of doing only these thankless chores and begins to make sense of some of the earlier mysteries of the workshop, his latent curiosity finally spurs him into action.

Often his first indication of interest in learning a new task is to inquire about the name or function of a particular part. After [illegible] some [illegible] basic information about the part, his next step most likely will be to one day wander over to the section of the workshop where a repair of that [illegible] being made. He may at that time express [illegible] desire to learn that repair job by asking one of the workers to teach [illegible] what they are doing. However, since he does not know the specific repair procedures for the job, he probably will not be invited to help with any of the really skilled work. But if he is still intent on learning, he will show his willingness to be of service to them by fetching tools, helping to lift something, cleaning small internal parts or steadying a part while another man works on it. These small services will usually gain him the favor of one of the experienced seniors, who may then take him under his wing and show him what he knows.

The young apprentice probably will be content to observe the others work this first time and perhaps the next several times that the same repair is made in the workshop. How many times an apprentice observes a repair job before attempting it himself depends, of course, on the difficulty of the repair, the need for his services by the apprentices engaged on the job, their willingness to have him assist, as well as his own confidence in asserting himself. On a simple job, an apprentice may only observe once or twice before becoming involved in the work; for other jobs, he may observe for as long as three months or more before attempting it. Throughout this observation process, the apprentice will add to his understanding by continually posing questions to his co-workers: general questions about the part, its function in the vehicle, and the details of its repair.

One apprentice describes the qualities he needs in learning a new repair job:

> First you must put your mind on that work all the time and watch to see when the work you want to learn has come into the workshop. You have to be very serious that day

> and give a good helping hand. By giving a helping hand, you'll make a mistake and the senior will correct you and you'll know. That is the start of what you want to learn. Also, you have to ask questions about what you don't understand. I'll watch the first time. Then after doing the work four or five times, I'll know how to go about it myself and I'll work on it straightaway.[1]

While many of the more difficult repair jobs cannot be mastered with such apparent ease, this apprentice's account of the learning strategy involved is fairly typical of what most apprentices experience.

Apprentices become conditioned to this observation/participation mode of learning from their first day in the workshop. Upon entering, an apprentice is usually assigned by the master to work alongside another young apprentice and "do what he does." This practice of emulating the actions of older, more experienced apprentices continues right up to the advanced stages of the apprenticeship, by which time the apprentice has probably assumed the position of role model himself. Apprentices no doubt feel comfortable with such a learning style. It is a familiar means of transmitting knowledge and skills in many traditional learning settings in African cultures, including the child's learning of farming and homemaking skills.

But observation does have limitations and the use of it as the sole mode of learning appears to be insufficient for many apprentices--especially with a subject as highly technical as motor mechanics. This would seem to be the reason why apprentices generally insist that they need the regular explanations given by older apprentices and the master to guide them in their learning and clear up any confusing aspects of the daily work. Some apprentices even believe that dependence on observation alone in learning motor mechanics may actually give them incorrect ideas.

In order to receive such explanations, however, apprentices usually must ask questions of their masters and seniors. Very little unsolicited information is ever offered in the wayside mechanics workshop, unless it is intended to correct an apprentice who has made or is about to commit a mistake in his work. Those masters who are not averse to explaining things to their apprentices do generally require apprentices to ask questions first about what they do not understand before giving out the explanation. There is nothing in the workshop that resembles a formal lesson; nothing like teaching in the sense of school instruction. Masters do not set aside any particular time for teaching apprentices. Explanations, when they are given, are usually in conjunction with the ongoing work in the workshop. Even the most able masters, who have considerable schooling and formal training in mechanics, believe that it is unwise to teach apprentices in any formal manner since they will only soon forget what they have been taught.

There are differences, however, in the amount of explaining that masters do for their apprentices. Illiterate masters, in particular, seem to have some difficulty in explaining things to their apprentices. One of the most competent illiterate masters in Koforidua, Kwesi Ayigbey, who was profiled in Chapter III, himself admits that, when helping apprentices through a difficult problem, he prefers to do the work himself and have the apprentices watch, rather than to explain the procedures to them. His statement concurs with the testimony of many of his apprentices, who often cite his reluctance to give verbal explanations. These apprentices admit that they pay close attention to their master when he demonstrates the work, rather than trying to rely on his less frequent and too brief explanations.

On the other hand, George Adumoka, an equally competent master with considerably more formal schooling and formal mechanics training, has--according to his own statements and those of his apprentices--far less difficulty in explaining specific repair procedures to his apprentices, which he often does when they seem to be having difficulty or when they come to him with questions. As an indication that all apprentices share a common dependence on explanations, a large percentage of the apprentices interviewed in the study stated that they would prefer to have their masters devote more time to teaching them what they know about mechanics.

Masters also on some occasions ask questions of their apprentices to probe the extent of their understanding. Many of these questions come during engine overhauls, which is a very difficult repair operation involving a number of very delicate procedures. Master mechanics attach particular importance to the engine overhaul, believing that much of their reputation as a mechanic rests on the quality of their overhaul work. It is understandable, therefore, that they would want to make certain that the workers who are helping with an overhaul know what they are doing.

There is no testing of an apprentice's knowledge and skills in the same sense as a school exam. However, his mechanical competence is nonetheless regularly evaluated in the checking of the repair jobs by the master and the oldest seniors. Little praise and virtually no material reward is ever given for a job well done. Instead, the apprentice's reward consists of having gained the master's confidence in his ability to conduct that same repair job next time. For a job done badly, punishment will be visible and swift. The apprentice will be soundly criticized and warned, perhaps shouted at and possibly ordered to perform some menial task or assume a humiliating posture. At the very least, he is likely to lose the master's confidence in his ability to handle the same repair again.

The Workshop Hierarchy

The basic mode of learning that has just been described operates within an organizational structure that vaguely resembles a military unit. Relationships between workshop personnel take the form of a hierarchy, with clear-cut levels of power and a chain of command. The power of the individuals in the hierarchy (i.e., the workers) is determined almost exclusively by the length of time they have spent in the workshop, although in a few instances age and competence also count heavily. Although it is only informally understood by the participants, this hierarchy plays a crucial role in the day to day management of work in the wayside workshop. It also influences the skills learning process in a very significant way.

As one would expect, all decision-making power in the wayside mechanics workshop ultimately flows from the master himself. It is, after all, the master who sets up the workshop in the first place, establishes basic policies such as the types of vehicles on which he will work and the rates that will be charged for services, takes control of the finances of the workshop, selects the workers and decides how to train them and utilize their labor. Although the master is, in the final analysis, the repository of power in the workshop, he does not always choose to exercise all of this power himself. He regularly delegates some of his powers to other workers in the workshop. Thus, power emanates downward through the ranks of the workers--the seniors, the older apprentices, the intermediate apprentices, and so on--in decreasing amounts the lower one gets in the hierarchy.

This hierarchy influences the operation of the workshop and the training of the apprentices in several ways. For example, the Shop Assistant along with the most experienced seniors are entrusted with a considerable responsibility to supervise the work and behavior of the younger apprentices. While the master normally takes charge of assigning apprentices and seniors to jobs, he is not always present in the workshop to perform this function. In his absence, the seniors are expected to do this. Either through a decision of the Shop Assistant or by mutual agreement among themselves, the seniors are dispersed to the various jobs in the workshop, who in turn select the apprentices to work alongside them as helpers. While this all sounds quite deliberate, the process actually takes place rather informally and quickly. As each group works on its particular job, the senior in the group (or the most experienced senior if there is more than one senior) acts as a kind of team leader in supervising and checking up on the quality of the work. Even if the master is present in the workshop, this method of job allocation and team selection is often followed unless countermanded by the master.

Seniors and advanced apprentices have a number of other special responsibilities. They often talk to drivers when a vehicle is first brought into the workshop to determine what symptoms the vehicle has. They are often sent to the road along with a less experienced apprentice to help repair a disabled vehicle. One of the more responsible seniors is often sent to Accra or Kumasi to buy spare parts for the master. Although the master handles the workshop finances, the seniors usually know the charges made for different repairs and often collect them for the master.

Peer Training. The effect of this hierarchy is to create a kind of peer training system among seniors and apprentices. Seniors, rather than the master, assume the major role of training apprentices. While this policy is not written into the apprenticeship agreement, masters do expect seniors to teach the junior apprentices what they know about the mechanics work and seniors have been socialized to accept this role. A senior's failure or refusal to teach apprentices will likely earn him a reputation of being derelict of duty or evil and may even incur disciplinary action by the master. This pattern of teaching is not unlike the tradition of European craft guilds where the journeymen also played an important instructional role in the workshop.

There are probably many reasons why the seniors tend to handle the bulk of the training responsibilities. Perhaps most importantly, junior apprentices work regularly with seniors and advanced apprentices and a close working relationship naturally develops between them.

This relationship is reinforced by the fact that apprentices and seniors are closer in age than are apprentices and masters. Moreover, there is the essential fact that the practice of mechanics must be learned primarily through work--it does not lend itself easily to a school instructional process. Finally, the apprentices in the workshop reflect a wide spectrum of skill and experience. Therefore, any attempt by the master to administer a uniform instructional sequence to all his apprentices would be inappropriate given these differences. Since masters are unwilling to undertake the time-consuming task of preparing individualized lessons, they simply leave the one-to-one teaching to seniors and thus free themselves for troublesome problems and other important matters.

This practice of imposing training reponsibilities on seniors is institutionalized in the workshop through a series of techniques. One common practice is for masters to refer questions from apprentices to seniors rather than answering them themselves. Masters claim, with some justification, that this helps to consolidate the senior's understanding and also acts as a kind of test by embarrassing him if he doesn't know. More powerful still is the very quality control system itself. By assigning seniors to be in charge of the repair jobs in the workshop and then holding them completely accountable for the quality of the work, they ensure that the senior will closely monitor and explain the work, if necessary, to the other apprentices working with him. If one of his apprentice helpers makes a costly mistake, it is not the apprentice but the senior who will suffer the repercussions from the master.

Yet masters do perform important training functions in the wayside workshop. They give considerable advice and advanced knowledge and techniques to seniors, who in turn internalize them and pass them on to younger apprentices. Masters indirectly stimulate other kinds of learning by managing the workshop in such a way that seniors are left with considerable autonomy over the daily operations, often for lengthy periods of time during the day. For all practical purposes, "instruction" in the wayside workshop proceeds according to the following pattern:

$$\text{master} \xrightarrow{\text{teaches}} \text{seniors} \xrightarrow{\text{teach}} \text{apprentices}$$

Apprentices themselves look to the seniors as their "instructors." When asked from whom they learn more, the vast majority of apprentices report that they learn more from the seniors than from the master. They apparently feel far more comfortable asking questions of seniors than of masters. Some apprentices say that their masters do not mind answering their questions--but few of them actually ask many questions of their masters. Some older apprentices admit that they went for two years before ever asking their master a question. Many apprentices also say that they can more easily understand the explanations of the seniors, although some are afraid of some supposed flaws in the senior's knowledge.

Seniors also seem willing to accept their role as facilitators in the learning process. Some seniors claim that they are more willing than their masters to teach younger apprentices what they know and will do so even if the apprentice does not ask a specific question.

The only condition that seniors insist upon before explaining something is respect from the apprentice. This usually implies that from the earliest stages of the apprenticeship the young apprentice must obey the commands of the senior. These requests often involve rather mundane errands and tasks which lead some apprentices to think that they are constantly being sent away in order not to see what is going on in the workshop. Yet those who are humble enough to willingly accept these petty assignments will eventually pass the tests of obedience and respect for authority that earns them more favored treatment--i.e., being selected to help with more difficult jobs and have the work explained to them.

Worker Interaction

Having described the general nature of the skills learning process in the wayside mechanics workshop, it is useful now to examine more closely the patterns of verbal interaction and physical activity among the various workers. Such an examination will shed additional light on the dynamics of the skills learning process and help to lay the basis for an assessment of what skills and knowledge apprentices actually acquire during their training.

Documenting worker dialogue and activity is not an easy undertaking, however, especially for a foreign researcher. Much of the conversation among workers is in one of several local Ghanaian languages, in which the observer must be relatively fluent. The actual physical activity of workers, of course, can be easily observed and recorded by anyone. But the accompanying verbal interactions are needed to assess the full impact on learning from that activity.

An attempt was made to record and analyze some of the different kinds of worker behavior in the workshop. This was done through the use of several data gathering methods which were described in Chapter I. To re-capitulate that discussion briefly, these methods included the following:

1) Unstructured observation of the general activities of workers in the wayside workshop.

2) Timed observation of specific work activities performed by individual workers.

3) Observation of certain types of verbal statements and work activities using a coded observation instrument.

Unstructured Observation. The data obtained from the general unstructured observation, while the most impressionistic and least systematic of the three, does help to provide a meaningful context in which to consider the more detailed data from the other sources. The following case studies are brief accounts of five such observations made of various apprentices, seniors, masters or groups of each during their regular working activities.

Case I

> Two junior apprentices in Mr. Dogbe's workshop, a truck repair workshop, worked together grinding the valves on an engine that was being overhauled. The apprentices were working very seriously. At times they talked to one another, each showing the other how well he had ground his valve. (In the Ghanaian wayside mechanics workshop, grinding valves is a tedious but important task done by hand rather than machines.) They finished grinding these valves and washed the grinding debris off the valves in a pan of water. As they worked, they talked about the repairs to be made

3

on an Austin truck sitting in front of them. As they prepared to grind two new valves, the more senior of the two explained how to use the grinding powder that is put around the edge of the valve while it is being ground. As they worked on these valves, however, the grinding powder was used up and the two apprentices started grinding the valves with water.

Mr. Dogbe, the master, came by to see how they were doing and saw that they were using water to grind the valves. He became very annoyed at them and told them they should never grind a valve without grinding powder (which is the abrasive which actually grinds the metal). He brought some more grinding powder for them. The apprentices started grinding the valves again very seriously, this time without talking to each other.

Case 2

Kodjo, an apprentice in a Peugeot workshop, was working on a kingpin of a Peugeot car (the kingpin is the part on trucks and some cars that connects the front suspension to the front wheel). His master came by and told him he should work very quickly. The master took a hammer that the apprentice had been using and told him that he should scrape off the dirt and oil from the kingpin. The apprentice then started scraping it with a piece of metal for five minutes.

The master called the apprentice to come and give him a hand with another job. He asked Kodjo to bring along a certain wrench which he did. The master had wanted Kodjo to work quickly on the other job so that he could help on his own job by holding a bottle of brake fluid and pouring some into the master cylinder as he (the master) pumped the brake pedal.

After helping the master with this task, Kodjo went away from the workshop for a few minutes and then came back to his own job of scraping for a couple minutes. The master called him again to come and hold the bottle of brake fluid as he pumped the brakes.

Then Kodjo came back to his own work for several minutes. The master called him to bring a specific tool and Kodjo went to the tool shed to fetch it. He came back and told the master that he could not find the tool. The master then told him to work very quickly because he was going to send the brake cylinder to the big workshop in town where they have a machine that can test the cylinder. He wanted Kodjo to take it there.

Kodjo finished scraping the kingpin after several more minutes of work and went to wash the part in water. After he had finished cleaning it, his master called him again and sent him to fetch another tool. He returned to his own work and began cleaning the oil and dirt from the other kingpin. He then began to re-fasten the first kingpin to the steering rod. However, before he could finish doing this, his master called him to carry the brake cylinder to town.

Case 3

Kwesi Amoah is a senior and the Shop Assistant in Mr. Ayigbey's workshop. He has been in the workshop for seven years and is given full authority by the master to supervise all the workers when he is not there. When Kwesi was observed in the afternoon of a normal work day, he was not working on a particular job as he often does but was generally supervising the apprentices. He stood watching one group of apprentices work and told them to be careful with their work He told the group to hurry up for they had taken long.

He went away for a short time but came back and stood in front of the tool room, where he talked with a customer. After finishing his conversation, he came to look at the same group of apprentices for quite a while. He then moved around the workshop picking up stray tools. He told a group of apprentices to stop joking around and work. He went away from the workshop for a short time.

When he returned he stood and watched a group of apprentices working. He helped a bit with the work and sent one of the apprentices for a tool. After watching a while longer, he moved to another part of the workshop. When he returned he instructed the apprentices to begin to pack the parts away since it was then late afternoon. He walked away. The apprentices did not do as he had asked so he returned. He asked them if he was not the one who had just spoken to them. He watched as they began to pack away the parts in the tool room.

He beckoned a girl who was selling food and bought some snacks for himself. He asked some of the apprentices if they had their chop money for the day. As he watched one group of apprentices work, he asked a question and told them to lift an engine block off the ground. He told one apprentice not to eat anymore and to work seriously. He moved around the workshop for a long time. One apprentice called to him for help so he went over to find out what was wrong. He explained how to solve the problem to the apprentice and then went away to watch another truck being repaired. He talked with a customer about the truck the customer had just sold. He asked an apprentice to push a truck out of the way of another one which was being worked on. It then began to rain heavily and all work was stopped for the day.

Case 4

Paul is a senior of 5 years experience in the Akan Workshop. He was working on the diesel engine of a small passenger bus along with two other younger apprentices. Several other apprentices were also watching him as he worked. The engine had just been overhauled and the workers were re-assembling the cylinder head to the engine, which had already been re-mounted inside the engine compartment of the bus.

As the apprentices watched Paul, one of them asked him to explain how the action of the valves is timed exactly to the movement of the pistons in each cylinder. Paul explained to the apprentice how this operation is done. As he continued tightening the bolts on the cylinder head, he sent some of the young apprentices on errands to bring other wrenches and to bring him some water. The apprentice who had asked him about the valve timing explained to Paul how he thought the valve timing would be done.

Later on, the driver of the bus came into the workshop and Paul told him about what had caused the breakdown as well as other things about the vehicle. Paul asked one of the apprentices to go and bring a jack so that he could jack up one side of the engine and make it easier to tighten some of the bolts. He asked the apprentices who were watching if they knew who had removed the engine in the first place. He said that whoever it was had made the work very difficult now by the way he dismantled it.

After he finished tightening the cylinder head bolts, he asked another apprentice to bring him a feeler gauge from the master so that he could adjust the valves. However, when the apprentice came back, he said that because it was late in the afternoon the master had advised them to do that job the next day. Paul went away to watch another job in the workshop.

Case 5

Addo is also a senior in the Akan Workshop who has been there for four and a half years. He was working on a car which had been in the workshop for six months. The engine of the

> car had been overhauled but the job could not be completed because a new cylinder head gasket for this model was not available anywhere in Ghana. Addo worked with Paul, another senior, and two other younger apprentices. They were preparing to re-mount the engine back into the car after the owner had asked a friend in England to send him a new gasket so the job could be completed. The owner who was anxious to have his car back stood nearby watching them.
>
> Addo worked very hard. He told the owner that the fanbelt was worn out. The owner asked if someone could go to town and buy him a new one and Paul offered to go for him. Addo asked the other apprentices where the radiator was and Kwame, the oldest of the seniors, told him that it had been installed on another car some time ago. Addo complained that some workers in the shop do things without thinking. He left the job and sent out of the workshop for a while.
>
> When Addo came back to work, he ordered one of the younger apprentices to drain the fuel out of the injector pump on another vehicle. Another customer came into the workshop and Addo went to talk with him. Addo didn't do anything more on the other car until Paul, who had gone to buy the new fanbelt, returned from town. After trying the belt, Addo said that it was too big and would have to be returned to the spare parts shop. He told one of the younger apprentices to bring the oil dipstick for the car and the apprentice said they have been looking for it but haven't yet found it. Addo looked quite disgusted and told them their work was very poor. He ordered the apprentice to take part in looking for the dipstick.

Although these short vignettes are hardly exhaustive observations of wayside mechanics workshops, they do convey something of the flavor of the activity in those settings. One can notice several operating characteristics of wayside workshops in the sketches: the informality in grouping and assigning workers to the various jobs; the intense periods of work punctuated by all manner of interruptions ranging from errands to joking conversation; the occasional slipshod quality of the work, especially among the less experienced apprentices, and the anguished responses of the more responsible workers who will ultimately answer to either the master or the customer for such carelessness; the obvious division of labor between the experienced seniors and the master, on the one hand, who do the serious repair work, and the less experienced apprentices, on the other, who do much of the unskilled support work.

Timed Observation of Workers. Somewhat more systematic data about work activity are provided by the timed activity observations of a number of workers. These are really a very simple form of time-motion study similar to those used in industrial skill analysis. Below are samples of these observations for three different types of workers.

Case 6

Worker Observed: Moses Ofori Date: March 25, 1977

Status: Apprentice (6 months in workshop)

Workshop: Modern Motor Workshop (Mercedes-Benz sub-workshop)

Length: 66 Minutes Job: Dismantling Engine for Engine overhaul

Time Elapsed	Activity
3 minutes	Watched the master work on loosening engine bolts and dismantle engine
1-1/2 "	Locked flywheel so it wouldn't turn
2 "	Watched the master loosening connecting rods
7 "	Helped the master to remove pistons
4 Seconds	Held a hammer for the master
6 Minutes	Held the timing chain for the master as he watched the master doing nothing in particular
2-1/2 "	Watched the master work on crankshaft
4 "	Helped the master remove the crankshaft
3 "	Placed bearing caps with pistons so they would not be mixed up.
5 "	Watched the master work
3 "	Did nothing in particular
3 "	Went away from the workshop
8 "	Put the parts and tools in a Benz bus (which serves as a tools storage room)
6-1/2 "	Fixed a small problem with the front hood of a car
4 "	Looked for the key to the bus to lock the tools
3-1/2 "	Did nothing in particular

Case 7

Worker Observed: Victor Datsumo Date: April 6, 1977

Status: Apprentice (2-1/2 years in workshop)

Workshop: Akan Workshop Job: Repair of Carburetor and Ignition System and cleaning air filter

Length: 112 minutes

(Apprentice worked alone at first and with Addo, the senior, later on)

Time Elapsed	Activity
6 minutes	Worked on timing the breaker points
4 min.	Fixed the battery cable connections
9 min.	Went away to another part of the workshop
1-1/2 min.	Removed a part from another vehicle
2 min.	Tightened a nut on the fuel line to the carburetor
2-1/2 min	Started the car
4 min.	Went away to another part of the workshop
2 min.	Did nothing in particular
7 min.	Washed the air filter
5 min.	Did nothing in particular
2 min.	Put the air filter back together
3 min.	Went away to the tool shed and brought some tools for the master
1 min.	Put a battery into another car
5-1/2 min.	Continued putting the air filter back together
1-1/2 min.	Went to the tool shed for an open-ended wrench
4 min.	Tightened the nut holding the air filter
3 min.	Went away to another part of the workshop
1 min.	Watched the master work
6 min.	Went to the tool shed for a screwdriver
2-1/2 min.	Continued tightening the nut on the air filter
1-1/2 min.	Cleaned the car
4 min.	Went away to another part of the workshop
2 min.	Began working on the breaker points of another car
2 min.	Roamed about in the workshop
3 min.	Worked again on the breaker points
5 min.	Went away to another part of the workshop
1 min.	Came back to close the hood of another car
5 min.	Worked on a problem with the ignition system of the car
6 min.	Watched Addo work on the ignition system
2 min.	Did nothing in particular
3 min.	Watched Addo work on the ignition system
1 min.	Helped Addo with the work on the ignition system
4 min.	Went away

Case 8

Worker Observed: Teye Dogbe Date: March 2, 1977

Status: Master Job: Three Jobs--(1) repairing brake line, (2) rocker arm in engine, and (3) steering gear

Length: 66 minutes.

(Master worked alone)

Time Elapsed	Activity
2 minutes	Worked on a rocker arm of a truck engine
1-1/2 min.	Went to inspect a chassis that an apprentice was working on
2 min.	Looked for a metal plate to be used in an improvised repair of a steering gearbox
1-1/2 min.	Placed the metal plate on the steering gearbox to see how it fit
4 min.	Went to work on the rocker arm of the engine
1-1/2 min	Went back to working on the metal plate. Began hammering it to shape it to fit the steering gear
2 min.	Again tried the metal plate to the steering gearbox
4 min.	Hammered the metal plate once again
4 min.	Checked the fit of the metal plate on the steering bearbox again
1-1/2 min	Hammered the metal plate again
2 min.	Did nothing in particular
2-1/2 min.	Worked on the brake line of a different truck
5 min.	Did nothing in particular
2 min	Worked on the brake line
3 min.	Hammered the metal plate again
4 min.	Went to watch a group of apprentices work
3-1/2 min.	Went away from the workshop
8 min.	Worked on the rocker arm again
1-1/2 min.	Worked on an oil lubricating line
6 min.	Went away to another part of the workshop
4-1/2 min.	Worked on the oil line

Although they represent only a few workers from an already limited sample, these timed activity observations reveal some of the same characteristics of work activity that were present in the earlier unstructured observations; of which the division of labor among different levels of workers is perhaps the most obvious. The workers in the above cases represent three distinct levels of experience: a very young, inexperienced apprentice; a more advanced apprentice; and an older, well-seasoned master. All three were engaged in jobs of varying degrees of difficulty; jobs which roughly reflect the respective mechanical competancies of fitters at their stages of experience.

For example, although the young apprentice of Case 6 did, in fact, work on the difficult job of dismantling an engine for an overhaul, his activities consisted mainly of observing his master do the work and helping him only in simple ways. He held tools and parts, attended to minor tasks, and packed away the tools and parts in the tools room. This particular apprentice happens to be quite fortunate in that he is at present the only apprentice with his master and is therefore likely to observe and assist with even the most difficult of jobs, in spite of his short experience in the workshop. The more extensive experience of the advanced apprentice in Case 7 is demonstrated by the fact that he worked without supervision on two jobs of moderate difficulty--the repair of the carburetor and the ignition system--although, admittedly, he later required the aid of a senior to help him with the ignition problem. His work, apart from the few periods of idleness or moving around the workshop, was directed and purposeful and indicated that, in terms of these jobs at least, he had some sense of what he was doing.

The master in Case 8 had perhaps the most interesting configuration of work, alternating as he did between three different jobs in an apparent attempt to finish them all at the same time. His status as a master, however, is clearly discernable here, not just from the high skill level required for the three jobs or his checking up on the work of the apprentices, but also from his apparent ability to fashion an improvised repair on a reasonably complicated component. Improvised repair techniques are skills that one expects to find only among those who have for years successfully coped with the almost impossible spare part problems of wayside mechanics.

Coded Observation. The third source of data about verbal and work activity in the wayside mechanics workshop was the observation category system. As explained in Chapter I, this observation system consisted of a set of coded categories representing verbal statements and physical activities which were assumed to be important to the skills acquisition process. Table 2 below contains a list of those categories. A more complete description of the responses included in each category can be found in Appendix D.

TABLE 2

OBSERVATION CATEGORIES

Code #	Behavior Category
1	Commands or Directions
2	Explanations
3	Questions
4	Criticism or Reprimands
5	Praise or Recognition
6	Listening or Watching
7	Talk to Customers or Visitors
8	Active Work
9	Movement In or Out of Workshop
0	Miscellaneous Activity or Inactivity

Appendix E contains a sample coded record of an observation of two wayside workers. Table 3 below contains the observation tallies along with the percentage of tallies in each category of seven such observations: two masters, two seniors and three apprentices. Although all the observations that were made could have been compiled and displayed in this way, it was more instructive to present the results of these selected samples, which represent fairly typical response patterns for workers with those levels of experience.

Notice in the percentage figures that in every case there is a heavy concentration of tallies falling in the category of active work. Whether the worker is a master, a senior, or a junior apprentice, a substantial portion of his daily activity within the workshop--if these observations can be taken as representative of the entire working day--could best be described as serious work with little or no verbal interruption. This statement is, of course, subject to one important caveat. The likelihood of being actively engaged in work is dependent on the crucial variable of business activity; that is, the number of repair jobs brought into the workshop every day. But when vehicles are indeed present in the workshop to be repaired, wayside workers will usually be found actively working on them. Since only workers who were actively involved in repair jobs were observed, these data reflect periods when the workshops are relatively busy.

One can also see that there are only small percentages of tallies in any of the verbal categories. In fact, except for one

TABLE 3

SUMMARY OF OBSERVATION TALLIES

1. Worker Observed: D. M. Osei (Master)

	Categories											
	1	2	3	4	5	6	7	8	9	10		
Total Tallies	11	24	11	0	0	42	0	40	6	46	=	180
Percentage of Tallies	6%	13%	6%	0%	0%	23%	0%	22%	3%	26%	=	99%

2. Worker Observed: Kofi Tamakloe (Master)

	Categories											
	1	2	3	4	5	6	7	8	9	10		
Total Tallies	3	15	5	0	0	25	0	80	18	14	=	160
Percentage of Tallies	2%	9%	3%	0%	0%	16%	0%	50%	11%	9%	-	100%

3. Worker Observed: Jonathon Addo (Senior)

	Categories											
	1	2	3	4	5	6	7	8	9	10		
Total Tallies	7	13	12	2	0	25	2	99	5	9	=	174
Percentage of Tallies	4%	8%	7%	1%	0%	14%	1%	57%	3%	5%	=	100%

4. Worker Observed: Paul Daku (Senior)

	Categories											
	1	2	3	4	5	6	7	8	9	10		
Total Tallies	16	16	10	0	0	40	3	80	6	16	=	187
Percentage of Tallies	9%	9%	5%	0%	0%	21%	2%	43%	3%	9%	=	101%

5. Worker Observed: Joshua Asare (Apprentice)

Categories

	1	2	3	4	5	6	7	8	9	10		
Total Tallies	0	6	3	0	0	34	0	57	21	15	=	136
Percentage of Tallies	0%	4%	2%	0%	0%	25%	0%	42%	15%	11%	-	99%

6. Worker Observed: Kofi Obeng (Apprentice)

Categories

	1	2	3	4	5	6	7	8	9	10		
Total Tallies	0	0	1	0	0	24	0	14	22	6	=	67
Percentage of Tallies	0%	0%	1%	0%	0%	36%	0%	21%	33%	8%	=	99%

7. Worker Observed: Kwaku Frimpong (Apprentice)

Categories

	1	2	3	4	5	6	7	8	9	10		
Total Tallies	0	7	0	0	0	12	0	90	12	10	=	131
Percentage of Tallies	0%	5%	0%	0%	0%	9%	0%	68%	9%	8%	=	99%

instance, there were no tallies in either categories #4 and #5 for any of the workers, indicating that criticism and praise of other workers is not a particularly frequent verbal behavior in the workshop. However, one should note that the effect of a single act of criticism or praise could be far greater than its frequency would suggest. The presence of tallies in categories #2 and #3 suggest that a common mode of information transfer, and thus learning, is through questions and brief answers. In the tabulations for the three younger apprentices, Joshua, Kofi, and Kwaku, there are no tallies in category #1, suggesting that these junior apprentices have very little or no authority to give orders except to workers with less seniority than themselves.

The three younger apprentices also have larger percentages of tallies in category #9 than either the seniors or the masters, confirming the earlier observations that juniors are frequently sent on errands to collect tools or other supplies for older apprentices, seniors and masters. The somewhat less number of #9's in Kwaku's case is probably because he was working alone on the simple task of washing a car and did not have the need for nor was asked to fetch tools.

D. M. Osei's observation record perhaps typifies a master's role in the wayside workshop. Although he had large numbers of tallies in category #8 representing his steady work on the pistons of an engine, he also had large numbers of tallies in categories #1, #2, #3, #6, and #C. In the hour period in which he was observed, he obviously made a number of commands to his workers, explained things and gave out advice, and asked questions on numerous occasions. The considerable number of

#0 tallies are, for the most part, a record of the period of time in which he fell asleep--a behavior only a master would deign to do in the workshop!

Observation #4 above, that of Paul Daku, is actually a record of the observation session described earlier in Case 4. It represents a very typical example of the role of an experienced senior in the workshop. The large number of #8's, of course, reflects the hard work he was obviously engaged in during the observation period. The relatively low number of #0's and #9's attest to the fact that he was rarely idle and did little moving about in the workshop. Like his master, Paul's advanced skills, as well as his senior status, dictate that his time be utilized for repair work rather than menial tasks like fetching tools. These chores are done by the less experienced apprentices, as reflected in the relatively large number of commands (#1) given out to them by Paul. The presence of tallies in categories #2 and #3 represents the dialogue in which he became involved with one of the apprentices about certain repair procedures. As this brief verbal exchange suggests, Paul plays an important instructional function in the workshop learning system.

Table 4 contains the tabulations for an observation of an advanced apprentice in the Akan Workshop (see Appendix E for the complete record). In this instance, the apprentice, Joseph Mensah, was working with two other junior apprentices, Kwaku Frimpong and Tetteh Larbi, in removing the cylinder head from an engine. To provide some idea of what the actual dialogue was like, the observation session was tape-recorded in synchronization with the written coding of activities.

TABLE 4

Person Observed: Joseph Mensah Date: August 16, 1977

Status: Apprentice (4 years) Job: Removing cylinder head

Length: 30 Min.

Categories

	1	2	3	4	5	6	7	8	9	10		
Total Tallies	16	14	19	0	0	32	0	35	0	14	=	130
Percentage of Tallies	12%	11%	15%	0	0	25%	0	27%	0	11%	=	101%

Time Elapsed	Dialogue	Direction of Dialogue
8 Sec.	Have you finished yours? Not yet. I don't mean you; I mean Tetteh	Joseph to Kwaku Kwaku to Joseph Joseph to Kwaku
23 Sec.	Pause	
6 Sec.	You finished removing it? Yes. Give me the #17 and #13 wrench for trying something.	Joseph to Kwaku Kwaku to Joseph
50 Sec.	Pause	
6 Sec.	This part is long so it's knocking everything. Okay. Give me the hose.	Joseph to Kwaku Kwaku to Joseph
55 Sec.	Pause	
7 Sec.	Get me a hammer	Joseph to Kwaku
45 Sec.	Kwaku, hurry up!	Joseph to Kwaku
2 Min. 50 Sec.	Pause	
4 Sec.	Come, come. You come.	Joseph to Kwaku
45 Sec.	Pause	
4 Sec.	Come and remove the	Joseph to Kwaku

Time Elapsed	Dialogue	Direction of Dialogue
25 Sec.	Pause	
5 Sec.	Come and remove the water gauge.	Joseph to Kwaku
45 Sec.	Pause	
8 Sec.	Has it come loose yet?	Joseph to Kwaku
	Yes.	Kwaku to Joseph
30 Sec.	Pause	
6 Sec.	There are many to loosen and many also that are too tight	Joseph to Kwaku
25 Sec.	Pause	
6 Sec.	Haven't you removed one of these (cylinder heads) before?	Joseph to Kwaku
	No.	Kwaku to Joseph
1 Min. 8 Sec.	Pause	
14 Sec.	This is the ground wire and this is the heater itself.	Joseph to Kwaku
	Is this the heater?	Kwaku to Joseph
	It's the heater itself	Joseph to Kwaku
1 Min. 20 Sec.	Pause	
10 Sec.	I am left with one to loosen in front. I will hammer it first because it's an aluminum one and if it breaks. . .	Joseph to Kwaku
	Then trouble.	Kwaku to Joseph
20 Sec.	Pause	
5 Sec.	Remove the bolts.	Joseph to Kwaku
12 Sec.	Pause	

The tape-recorded dialogue was then translated and transcribed to the written form shown above. In addition to illustrating the content of the dialogue, this transcription served the additional purpose of checking the reliability of the earlier observations.

The distribution of tallies in this observation session shows a fairly typical behavior pattern for an advanced apprentice such as Joseph. Unlike some of the earlier observations of seniors and masters, this one contains a larger number of tallies in categories #1, #2 and #3, suggesting that there was somewhat more verbal activity than in the others. In terms of the nature of the dialogue itself, the most noticeable feature is its terseness. The simple one line commands, statements and questions are all indicative of a team of workers trying to accomplish a practical task. It is functional language for the type of work performed in the wayside mechanics workshop, and is typical of the vast majority of work-related dialogue that occurs there.

Yet, the terseness of the dialogue seems to relegate it to a rather narrow training function. It does not facilitate the transmission of large amounts of information nor does it appear to foster a more advanced understanding of motor mechanics among apprentices. Very little of the dialogue that accompanies work activity in the wayside mechanics workshops includes any extensive explanations or "why" questions and answers. Its sole function is to communicate essential information about repair procedures--information which allows workers to do their repair jobs expeditiously and in conformity with acceptable business practice.

Access to Learning Opportunities

Another factor that influences apprentice skill acquisition is the question of learning opportunity. That is, just how much opportunity does the average apprentice have to learn the skills of his chosen profession with some degree of proficiency? Does the wayside workshop in fact offer the frequency and the range of learning experiences to enable an apprentice to become both competent and versatile at his trade?In trying to answer these questions, one cannot forget the fact that, in contrast to the technical or vocational school, learning opportunities in the wayside mechanics workshop derive almost exclusively from the work itself. While observation, shop-talk, and verbal explanations are all essential elements in the skills learning process, true mastery of mecnanics skills can come only through the actual practice of these skills on real jobs.

Opportunities for apprentices to participate in the daily work of the wayside mechanics workshop are a function of several variables. The first and, perhaps, most important of these is the volume of business the workshop handles, particularly in relation to the size of its workforce. Simply speaking, how many vehicles regularly enter the workshop for servicing and how many workers are available to do the work? Is there enough business to engage all workers or must some workers remain idle while a few others take care of the few jobs that exist? Secondly, what are the frequencies of repair problems that these vehicles normally have? Is a wide range of repairs represented or only repetitions of a relative few? And thirdly, how are the specific repair jobs that arrive in the workshop distributed among the various workers? In other words, who does what work on which vehicle?

Daily Business Activity. An attempt was made to address some of these questions in a small sample of wayside mechanics workshops. Data on daily business activity were collected in four different workshops which were considered representative of all the wayside workshops in Koforidua. In each workshop, an older apprentice, senior or master was commissioned to keep a daily record of movements of vehicles into or out of the workshop, along with a breakdown of the tasks and the workers who performed them--something akin to a "job card" in a Western mechanical workshop. In spite of several thorny problems in establishing a regular and accurate record-keeping routine, a reasonably accurate picture of workshop business activity and task allocation can be constructed from the records these workers kept over a three month period.

Table 5 displays the records of daily business activity in the four workshops over a one month period in late 1976. In terms of the numbers of apprentices and their general volume of business, three of the workshops, the Akan Workshop, Mr. Ayigbey's Workshop and the Friendship Motor Workshop, would probably rank as large workshops, while the Modern Motor Workshop would rank as a small one. The data have been divided into three categories: 1) the number of cars (or trucks) coming in each day for repairs (labeled New Cars); 2) the number of cars already present in the workshop with repairs requiring longer than one day (labeled Old Cars), and 3) the number of apprentices who were in the workshop available to work each day. At the bottom of these columns the average number of new vehicles, old vehicles and apprentices per day

TABLE 5

DAILY BUSINESS ACTIVITY

Akan Workshop

Date	New Cars	Old Cars	Appren. Present
Nov. 3	4	6	15
" 4	5	8	14
" 5	3	10	10
" 6	2	9	7
" 8	3	11	10
" 9	1	10	8
" 10	1	10	13
" 11	4	10	12
" 12	0	9	14
" 13	0	9	13
" 15	2	9	14
" 16	3	8	14
" 17	3	9	14
" 18	4	10	14
" 19	2	10	13
" 20	4	10	14
" 22	1	10	14
" 23	0	10	13
" 24	2	9	13
" 25	1	9	13
" 26	1	8	13
" 27	2	8	13
" 29	0	8	13
" 30	3	8	13
Dec. 1	3	8	12
" 2	2	8	13
" 3	2	8	13

2 New Cars/Day
9 Old Cars/Day
13 Apprentices/Day
.85 Vehicles/Apprentices Ratio

Ayigbey Workshop

Date	New Cars	Old Cars	Appren. Present
Nov. 9	3	5	11
" 10	2	6	10
" 11	3	7	11
" 12	3	6	10
" 13	0	6	9
" 15	2	6	11
" 16	4	6	17
" 17	3	6	12
" 18	2	6	11
" 19	2	7	11
" 20	2	7	11
" 22	1	7	12
" 23	1	7	11
" 24	2	7	12
" 25	1	9	12
" 26	1	7	12
" 27	2	8	12
" 29	2	8	13
" 30	2	9	12
Dec. 1	2	8	15
" 2	1	8	10
" 3	1	8	11
" 4	1	9	12
" 6	2	9	12
" 7	1	9	12
" 8	1	10	12
" 9	1	10	12

2 New Cards/Day
7 Old Cars/Day
12 Apprentices/Day
.75 Vehicles/Apprentices Ratio

Friendship Workshop

Date	New Cars	Old Cars	Appren. Present
Nov. 5	6	0	12
" 6	6	1	12
" 8	5	0	13
" 9	7	0	15
" 10	3	2	15
" 11	2	3	15
" 12	3	0	13
" 13	4	0	6
" 15	3	1	6
" 16	5	1	6
" 17	3	0	6
" 18	3	0	13
" 19	2	1	13
" 20	3	0	14
" 22	3	0	8
" 23	0	0	10
" 24	3	0	10
" 25	4	0	10
" 26	4	1	13
" 27	4	0	13
" 29	4	0	13
" 30	3	0	10
Dec. 1	3	0	14
" 3	3	0	15
" 4	3	0	11

3.5 New Cars/Day
.5 Old Cars/Day
11 Apprentices/Day
.36 Vehicles/Apprentices Ratio

Modern Motor Workshop

Date	New Cars	Old Cars	Appren. Present
Nov. 24	0	1	4
" 25	3	1	4
" 26	0	1	4
" 27	0	1	4
" 29	1	1	4
" 30	0	2	4
Dec. 1	2	2	4
" 2	0	2	4
" 3	1	2	4
" 4	1	1	4
" 6	2	1	4
" 7	1	2	3
" 8	1	1	3
" 9	3	0	3
" 10	2	0	3
" 11	1	0	3
" 13	0	0	3
" 14	0	0	3
" 15	2	0	4
" 16	3	1	4
" 17	1	0	4
" 18	2	0	4
" 19	1	0	4
" 20	2	0	4
" 21	1	0	4
" 22	3	0	4
" 23	1	0	4

1 New Car/Day
1 Old Car/Day
4 Apprentices/Day
.50 Vehicles/Apprentices Ratio

have been displayed for each workshop.

Busier workshops like the Akan, Ayigbey and Friendship had two or more *new* vehicles coming in each day for repairs during that period. This daily average of two new vehicles for the Akan and Ayigbey workshops is not much different from the daily average of new vehicles for the small Modern Motor Workshop. But the big difference is in the number of *old* vehicles left for more extensive repairs. The large numbers of old vehicles in the Akan and Ayigbey workshops suggest that both workshops do a larger than average number of major repair jobs--for example, engine overhauls, repairs of clutches, gearboxes and differentials. These repairs often require that vehicles be left in the workshop for several days and sometimes weeks or months, not only because of delays in getting spare parts, but also because a great deal of dismantling, trouble-shooting and reassembly must be done on them. Major jobs, therefore, tend to provide considerable ongoing work for apprentices, supplementing the minor repair jobs that come in every day. In contrast, the Friendship and Modern Motor Workshops have a much smaller number of old cars, suggesting that relatively few such major repairs were being done in those workshops. Consequently, their apprentices probably received somewhat less experience in repairing major vehicle components.

Although the exact causes are not clear, this discrepancy in the frequency of major repair jobs appears to be strongly linked to the highly esteemed reputations of the two masters of the Akan and Ayigbey workshops. Both masters are generally regarded by their customers, their apprentices and the artisan community as being among the best at their craft. A driver who may not hesitate to take his vehicle to almost any mechanic for a minor repair may carefully seek out master mechanics such as Adumoka and Ayigbey when faced with the need for an engine overhaul, for example. Apprentices in both these workshops often cite cases of drivers who bring their vehicles from far away places just to have their masters work on them.

Another interesting statistic in Table 5 is the ratio of vehicles to apprentices in each workshop. The vehicle-to-apprentice ratio is substantially higher in the Akan and Ayigbey workshops (.85 and .75 respectively) than in the Friendship and Modern Motor workshops (.36 and .50 respectively), suggesting that the former provide significantly more learning opportunities to their apprentices than the latter. At first glance, this result seems surprising in the case of the Friendship workshop with its relatively large number of new cars per day. But this workshop has few old cars, indicating that few major repairs are done there. In addition, the Friendship workshop is visibly overstaffed with apprentices. The two older masters who operate the workshop have the distinct disadvantage of having been trained--and therefore being experienced--only on models that are no longer being imported into Ghana in large numbers. This same handicap was mentioned in Chapter III in reference to Samuel Asumanu, the proprietor of the Modern Motor Workshop.

Frequency of Repairs. It is helpful to take a closer look at the frequencies of specific jobs and their patterns of distribution among the workers. Appendix F provides a complete breakdown of repair jobs and the apprentices assigned to those jobs over a one month period in the Akan and Modern Motor workshops. Table 6 summarizes some of

TABLE 6

REPAIR JOBS HANDLED ACCORDING TO DIFFICULTY

Difficulty of Job	Akan Workshop	Modern Motor Workshop
Easy to Moderate	55%	69%
Difficult	45%	31%

Note: These figures are taken from the complete record of business activity over a one-month period contained in Appendix F. The percentages are obtained from dividing the number of difficult and moderately difficult jobs in each workshop by the total number of jobs for the time period under study.

these data by comparing the percentages of the repair jobs handled by the two workshops according to their difficulty. Repair jobs of low to moderate difficulty--for example, oil change, general maintenance, repair, replacement or adjustment of radiator, brakes, spark plugs, contact set, carburetor, fuel pump, shock absorbers, and front suspension--made up 69 per cent of the total jobs in the Modern Motor Workshop, as opposed to 55 per cent of the total jobs in the Akan Workshop. This suggests that apprentices in the Modern Motor Workshop work more often on jobs involving minor maintenance and repairs of less complex components than do apprentices in the Akan Workshop. On the other hand, more difficult repair jobs--e.g. engine overhauling and repair of the clutch, gearbox, and differential--made up 45 per cent of the total jobs in the Akan Workshop compared to only 31 per cent of the total in the Modern Motor Workshop.

This confirms the earlier observation that apprentices in the Akan Workshop get more experience in doing major engine overhauls and repairs of complex components than apprentices in the Modern Motor Workshop. One sees this same pattern in the masters' own estimates of the number of major repair jobs in their workshops. George Adumoka of the Akan Workshop, estimates that he handles an average of one engine overhaul, four gearbox repairs, and twelve clutch repair jobs every month. Samuel Asumanu of the Modern Motor Workshop, on the other hand, estimates that he gets only one clutch repair and two gearbox repairs a month and only three engine overhauls a year.

In looking at the frqeuency of the different repair jobs in the two workshops, it is clear that an apprentice may have to wait several months before being exposed to one of the less frequent jobs, such as repair of the differential, water pump or rear wheel bearings, for example. This is particularly true given the fact that only two or three apprentices often work on any one job, affording little chance for the other apprentices to participate in the work. Moreover, the master himself will often prefer to do some of the more delicate and difficult repair operations, such as passing the bearings (i.e., torque-tightening the connecting rod bearings to the crankshaft) or adjusting the valves on an engine overhaul, for example. It is little wonder then that apprentices often have to continue working in their master's workshop for several years until they manage to build up a full repertoire of mechanics skills.

One might argue that a small workshop like the Modern Motor Workshop, which has such a low volume of business in general, would offer few opportunities for apprentices to really gain practical experience. This is probably the case in a number of small workshops in Ghana. Yet, ironically, with only four apprentices such a workshop could conceivably provide as much or even more sustained activity for all its apprentices than some busier workshops. Indeed, small workshops have the potential to expose their few apprentices to a wide range of learning opportunities at an early stage of training because even the youngest apprentice plays some role in all the jobs that come into the workshop.

A Typical Workday. A brief look at a typical workday reveals much about how the day's work is allocated among the various workers. November 30th was one such day in the Akan Workshop. Table 7 reveals

TABLE 7

ALLOCATION OF WORK ON A TYPICAL WORKDAY
Akan Workshop--November 30, 1976

Vehicles Present in Workshop for Repairs	Job Breakdown	
	Specific Job	Workers Who Handled Job
3 New Vehicles	1. Maintenance--repair of door	Paul Daku
8 Old Vehicles	2. Brake Adjustment	Paul Daku Victor Datsumo (Helped)
	3. Remove and clean spark plugs	Joshua Asare
	4. Remove and clean jets in carburetor	Atta Owusu Paul Daku Kwaku Frimpong (Helped)
	5. Replace contact set	Paul Daku
	6. Remove cylinder head for enging overhaul	Joseph Mensah Yaw Baffoe (Helped)

Workers Present That Day*	Training/ Experience	Worked On A Specific Job?
1. Kwame Nortey	58 months	
2. Paul Daku	58 months	X
3. Yaw Baffoe	44 months	X
4. Charles Osu	43 months	
5. Joseph Mensah	42 months	X
6. Kofi Obeng	35 months	
7. Kwesi Asiedu	30 months	
8. Victor Datsumo	27 months	X
9. Atta Owusu	22 months	X
10. John Afedu	17 months	
11. Kwaku Frimpong	13 months	X
12. Joshua Asare	9 months	X
13. Kwadjo Appiah	2 months	

*3 workers were Absent

that on that day three new cars came in for repairs and eight old cars remained in the workshop from the previous day. Thirteen apprentices came to the workshop for work that day. The only real work appears to have come from the three new cars, since the old cars were all undergoing more extensive repairs and were not being actively worked on while spare parts were unavailable. According to Table 7 these three vehicles generated six specific jobs, which were divided among seven of the apprentices. The apprentices who were present in the workshop that day are listed with an "X" beside the names of those who actually worked on the jobs.

Of the thirteen apprentices present in the workshop that day, six were apparently not involved with any of the jobs. This fact does not mean that the six were not actively working or learning at the time. It probably does mean that they were on the periphery of focused repair activities that day. They were not engrossed in a single job, seeing it through from start to finish. They may have been moving around the workshop assisting others in nominal ways. They may have been observing other apprentices do their work. One of them might have been sent by the master to purchase spare parts. Or a younger one among them may even have been sent to the master's house to assist the master's wife in preparing the evening meal.

The essential point, though, is that even on a day of average business in a comparatively busy workshop, there is not enough business to actively engage all the apprentices in specific repair jobs. This is a rather typical feature of wayside workshops and can become an acute problem in those workshops where the volume of business is declining and the master attempts to make up for his lost income by taking on more apprentices than his business justifies. This is the situation that was noted above in the case of the Friendship Workshop. In workshops where apprentices greatly outnumber jobs, there are sometimes high absenteeism and misbehavior by idle apprentices, as well as the feeling among the more conscientious apprentices that they are not getting enough opportunities to learn essential skills.

In contrast to the Akan Workshop, all the apprentices in the Modern Motor Workshop were usually fully occupied with specific repair jobs on many workdays during the month. December 3rd was a typical workday in that workshop. According to Table 8, one new car came in for repairs and two old cars were already there, one of which was being worked on that day. The three cars generated three jobs, which were allocated as shown among the four apprentices. Obviously, not all four apprentices played equal roles in the work on these jobs. The youngest apprentice, Danso, who had been present in the workshop for less than a year, only jacked up the cars, fetched the tools and cleaned parts. On the engine overhaul job, the two middle apprentices assisted the oldest apprentice, Atsu Ayitey, who assumed the main responsibility for the work. This same pattern was repeated on other workdays throughout the month, where, more often than not, the four apprentices worked on jobs as a unit. Although the workshop did not, by any means, have an abundance of business nor did much of its business consist of repairs of major components, the apprentices did seem to get regular exposure to a variety of focused repair activity.

TABLE 8

ALLOCATION OF WORK ON A TYPICAL WORKDAY
Modern Motor Workshop--December 3, 1976

Vehicles Present in Workshop for Repairs	Job Breakdown	
	Specific Job	Workers Who Handled Job
1 New Car	1. Change of oil	Daniel Boateng
2 Old cars	2. Repair of upper arms of front suspension	Daniel Boateng Atsu Ayitey (Helped) Kobina Ezeh (Helped) Martin Danso (Helped)
	3. Installation of new connecting rod bearings on engine for engine overhaul	Atsu Ayitey Martin Danso (Helped) Daniel Boateng (Helped) Kobina Ezah (Helped)

Workers Present That Day	Training/ Experience	Worked On A Specific Job?
1. Atsu Ayitey	34 months	X
2. Daniel Boateng	14 months	X
3. Kobina Ezeh	13 months	X
4. Martin Danso	11 months	X

Trade-offs Between Work and Training. There is an important corollary issue here: that is, the trade-offs that sometimes have to be made between the demands of the work and the learning needs of apprentices. For example, two of the youngest apprentices in the Akan Workshop are often the only ones the master asks to remove radiators from vehicles. Understandably, in his view, the skills of these two apprentices are limited at this early stage of their training and the simple task of removing a radiator is one of the few that they have learned well. Nonetheless, their continual repetition of the task, after they had already attained complete competence in the skills, may well have deprived them of opportunities to learn other skills.

Other examples of such informal trade-offs abound. Paul Daku, one of the older seniors in the Akan Workshop, is, for all practical purposes, the master's spare parts purchaser. Paul is frequently sent to Accra and Kumasi to locate and purchase spare parts for the various repair jobs in the workshop. These missions often take him away from the workshop for days at a time, much to his dismay, since he feels that his mechanical skills suffer in the process. However, one could argue just as easily that Paul grossly underestimates the future value of such experiences, since personal contacts with spare parts dealers are at a premium in a country so distressingly short of spare parts. Indeed, it is the other seniors who may well have cause for concern in not having such contacts for the time when they open their own workshops.

Earlier sections already described how young apprentices are kept busy fetching tools, cleaning parts, etc. so that older more experienced apprentices and seniors can do the main work. This too, like many of the other decisions made by masters and seniors in the workshop, is a trade-off made in favor of the business operation, since it utilizes the skilled labor in the workshop more efficiently and thereby maximizes profit. Predictably, many young apprentices look rather negatively on the early stages of their apprenticeships, often reporting cases when they are sent on seemingly pointless errands, as if to keep them from seeing how the work is done. This sort of labor utilization puts a great deal of emphasis on the initiative of individual apprentices to seek out new learning experiences. They often appeal to an older apprentice they have befriended to show them how to do a certain job in return for performing the menial tasks of that apprentice. In a sense, the entire apprenticeship can be seen as a balancing act of trying to gain opportunities to learn new skills while at the same time being used for tasks that one already knows well.

There is another aspect to this issue of trade-offs between the commercial and the educational functions of the workshops. As a business operation, the workshop, of course, must accept whatever repair jobs that the motoring public brings in on a daily basis. This daily variability in the work affects the skills learning process as well. For example, it is difficult to plan ahead what an apprentice will learn or to properly reinforce his learnings from a previous day when the jobs change from day to day. If an apprentice works on a brake repair job one day, a fuel line problem the next day, and an engine overhaul the next day, he may not consolidate his learning on any of these tasks until much later, although admittedly he has been exposed to a wide range of the mechanic's stock in trade skills in a short period of time.

where he might master a repair skill with relatively few closely spaced repetitions, he may require a comparatively large number of repetitions of that same skill when they are widely spaced.

The Nature of Motor Mechanics Skills

So far, the process by which Ghanaian apprentices acquire skills in motor mechanics has been examined in some detail, along with the kinds and frequency of opportunities that exist in the wayside mechanics workshop for learning these skills. One of the most important areas, however, concerns the very nature of the skills themselves. Exactly what kinds of skills do apprentices learn during the several years of their apprenticeships and how well do they actually learn them? Do they emerge from their training as virtual experts in the trade, or must they spend several more years in another setting acquiring additional skills or refining the ones they have?

In trying to answer these questions, it is useful to first consider some of the insights gained from studies of industrial skill acquisition in Western societies. These studies, which generally fall under the heading of Industrial Engineering or Ergonomics, have attempted to investigate the broad range of skills practiced in the industrial workplace, among which would be included the skills of motor mechanics and similar maintenance professions. A major purpose of these studies has been to try and unravel the specific elements of different industrial skills and discover how they are coordinated into overall operations. This information, along with a reasonable estimate of what constitutes good performance of the skills, can be used to design a training program or modify plant conditions to maximize that performance.

One of the basic understandings contributed by these studies is the notion that industrial skills are comprised of two general components. 1) a knowledge component made up of symbolic information, and 2) a non-symbolic activity component made up of motor and perceptual skills, both of which are combined in different proportions for different skills.[2] The exact "mix" of knowledge and activity in a given skill as well as the demands made on the brain's decision-making capacities largely determine its difficulty. For example, a less difficult skill would be one in which the knowledge component is relatively small and the learner can devote most of his attention to the activity part of the skill. In contrast, a more difficult skill would be one in which the knowledge component is quite extensive or where new knowledge must be continuously processed at the same time that the purely motor activities are being executed.

Within the ever expanding universe of industrial skills, there is almost an infinite number of ways that knowledge and activity can be combined. At one end of the spectrum, one finds the repetitive assembly-line tasks, which require little in the way of knowledge, but, instead, only adept coordination of perceptual-motor responses for skilled performance. At the other end of the spectrum are the corrective maintenance skills of the technician and the mechanic, which demand not only an extensive knowledge of the equipment, but also some sophisticated diagnostic skills.[3] The skill repertoire of the auto mechanic incorporates a similarly diverse continuum of skills, ranging from the most repetitive, routine tasks all the way to the most complicated diagnostic operations. This range of complexity can perhaps best be illustrated with a brief analysis of two very common, but very different, workshop tasks.

The task of removing a wheel from a vehicle is a familiar one to any mechanic or service station attendant. Basically, only two operations are involved: safely jacking up the vehicle and then loosening and removing the lug nuts holding the wheel to the axle. Removal of the lug nuts requires that the mechanic correctly estimate (or find by trial and error) the size of wrench that will fit the nuts and then apply an adequate amount of torque to the right direction to loosen them in turn. With the jack raising the vehicle high enough, the wheel is simply pulled off.

In performing this task, never does the mechanic have to ponder over anything or to take account of any knowledge other than some very simple sensory data. Unless he is a rank beginner, he can execute the task almost reflexively. Increased speed and smoothness in his performance will come with improvement in his hand-eye coordination and his estimation skills.

On the other hand, the task of finding the fault that prevents a car from starting is an equally familiar task, but one which involves quite a different configuration of knowledge and activity. In this case the mechanic may have to execute a number of motor and perceptual skills, some of which are very delicate. More importantly, however, he must also perform a rather complex mental operation. He must correctly identify the actual cause of a malfunction, given only some general symptoms that very often apply to several different faults.

For example, there are numerous possible causes of an engine that fails to start, as well as a host of plausible ways to go about locating the cause. To accomplish the task expeditiously, however, it is helpful if the mechanic conceives of the vehicle as a coherent system composed of several distinct but interrelated sub-systems. By taking a systems view of the vehicle, he can more easily see that the fault in this case probably lies within one of four relevant sub-systems: the ignition system, the fuel delivery system, the carburation system, or the engine compression system. From here he can follow one of two courses. He can resort to the random replacement of the various components in the suspected systems until the problem is eliminated. Or he can select the more efficient strategy of administering a series of tests--moving from easier to more difficult--which will ultimately isolate the faulty component. Appendix G contains a simplified flowchart of one possible sequence of steps that will successfully isolate the cause of a starting malfunction.

Even a cursory look at the solution path in this example will confirm that considerable task-related knowledge is needed to make a successful diagnosis. The mechanic must have at least a rudimentary understanding of the relevant mechanical systems involved in order to match the symptoms with the correct systems and to make reasonably confident predictions about which faults are potentially responsible for the malfunction.

Yet, if the problem is to be solved in anything but random fashion, more than knowledge alone will be necessary. The mechanic will also need to think logically and methodically about that knowledge. If the fault is not altogether obvious, he must be able to devise an heuristic learning strategy that will help in separating the inoperative effects of the malfunction from its true cause. Such a strategy is likely to look something like the following: first, formulating an hypothesis of the probable cause; second, planning and administering a test sequence to test that hypothesis; third, accurately interpreting the test data; and fourth, if necessary, formulating alternative hypotheses of the probable cause on the basis of the data garnered from the tests.[4] It is precisely this kind of problem-solving or "eliminatory" thinking, as Seymour[5] calls it, that is so intimately associated with--and, indeed, is the very essence of--the art of fault diagnosis.

Between the extremes represented by these two examples come the many fine shadings of skills that together round out the complete spectrum of motor mechanics skills. These skills, like the two examples above, are made up of different proportions of knowledge and activity arranged in a multitude of combinations. As such, they impose equally varying demands on the abilities of those workers who must learn to execute them. Collectively, they comprise the expert mechanic's entire skill repertoire, rendering him competent to deal with the gamut of workshop repair problems--from changing the oil to overhauling an engine that burns oil.

A Conceptual Framework of Apprentice Skill Formation

From the very outset of the study, the task of assessing the skill competence of apprentice mechanics seemed formidable. As an earlier discussion noted (see "Limitations of the Study," in Chapter I), such an endeavor involves several conceptual and methodological problems. For example, one set of problems concerns the informal style of learning in the wayside mechanics workshop. The loosely structured, unspecified nature of apprentice training frequently makes it difficult to know which, if any, skills and knowledge are being transmitted to learners. Moreover, there is a great deal of diversity to contend with, both in terms of the skills to be learned and the workers' acquisition of them. As one can see from the preceding section, the skill repertoire of the professional mechanic is both extensive and varied--a fact that no doubt accounts in part for the uneven distribution of skills among the workers in wayside workshops. Compounding all this are the numerous individual differences of the workers themselves. In a typical wayside workshop, the workers represent a disparate collection of ethnic and language backgrounds, ages, levels of schooling, and innate abilities.

Chapter I concluded that a tentative conceptual framework is needed to help reduce some of this incomprehensibility and provide structure for the study. At minimum, the framework must incorporate the two salient features of wayside workshop training mentioned above: the wide variation in skill mastery among wayside workers and the considerable diversity of the skills they learn. It must also take into account the rather long duration of apprenticeship training, during which skill learning appears to progress in slow, incremental steps. The purpose of the framework is twofold: 1) to describe the process of skill formation in a manner that generally conforms to the experience of all apprentices, and 2) to serve as a criterion against which the skill competencies of workers can be compared.

To create such a framework, the apprenticeship experience was sub-divided into clearly identifiable stages of skill growth. Skills that possessed common functions or other similar attributes were grouped together and organized into an overall scheme. The scheme that seemed most consistent, both with the generally accepted profile of a professional mechanic and the informal mode of skill transmission in the wayside workshop, was a three-tiered hierarchy of skill development. Under this conceptualization, an apprentice was assumed to pass through three distinct and increasingly sophisticated levels of skill achievement.

The first and lowest level of skill mastery consisted of all simple, repetitive activities--the kind that are commonly performed by service station attendants in the United States. These would include such tasks as: removing a wheel to change a tire; changing the oil; fetching tools and equipment and later cleaning and returning them to storage at the end of the day; steadying parts for older workers; cleaning small parts; loosening and tightening nuts and bolts (but not disassembling components); removing and installing simple components such as radiators, air filters, oil filters, batteries, fan belts, etc., and generally knowing the types, names, and sizes of tools and equipment in the workshop. This level would also include such non-mechanical tasks as sweeping out the workshop everyday and running any number of petty errands for older apprentices, seniors, and the master.

These tasks obviously require very little systematic knowledge of either the structure and operation of specific components or of the vehicle as a total system. Skillful execution is primarily a matter of proper coordination of the relevant perceptual-motor activities. Although decisions frequently have to be made in performing one of these tasks, the appropriate responses are quickly learned (as, for example, in selecting without hesitation or measurement the correct size wrench to fit a particular bolt). Level I skills are usually easily mastered, both because of their nature and also because they tend to be repeated a great many times every day, particularly in the early stages of the apprenticeship.

The second level of skill mastery encompasses a broader class of skills, reflecting a far more thorough knowledge of the component systems of the vehicle. A mechanic who performs at this level has the ability to disassemble, repair, re-assemble and re-install any component part of the vehicle. To have attained this level of competence, he not only must have mastered the simple knowledge and fundamental motor skills of Level I, but also have learned how to apply them to more complex tasks. In addition, though, he must also have acquired a very _different_ set of skills associated with this more advanced level of mechanical competence. For example, he would need to have formed detailed mental pictures of each component so that he knows intuitively how intricate parts fit together (or can easily figure out how they fit together through a short trial and error process) and in what order they should be disassembled and assembled. Each of these mental images would also assist the worker in determining whether a given component is functioning normally or not, by providing a standard for what a normal component should look or sound like. Although he can repair each of the components and has a limited knowledge of how they work as separate units, he may only vaguely comprehend how they function within the larger context of the vehicle itself.

The third and highest level of mechanical competence is characterized by a discerning systems knowledge of the vehicle. At this level, the worker has a detailed knowledge of how each component operates. But, in addition, he also understands how all the components operate in unison to form a functioning motor vehicle. It is only at this level, therefore, that one finds highly developed fault diagnosis skills, since these skills often depend heavily on a knowledge of the interrelationships between component systems. As was apparent in the starting problem in Appendix G, the exact causes of vehicle malfunctions are not always (or even very often, for that matter) obvious in the symptoms they produce. While the less-experienced mechanic would be uncertain about where to begin, the Level III mechanic can tell which components are suspect from the symptoms produced and can devise a strategy to isolate the actual one causing the fault; a task calling into play both his systems knowledge and his analytical thinking skills. Obviously, once a fault has been isolated, a Level II mechanic could be called in to repair or replace the defective part. But the ability to locate the fault in the first place is an essential part of what it means to be fully competent as a motor mechanic.

Polyani and Prosch offer an interesting analogue to the above skills hierarchy in their book Meaning. They illustrate how the performance of a particular skill (in this case, the production of oral communication) can be divided into a series of levels and how these levels are sometimes intimately interconnected.

> At the lowest level (1) there is the production of voice sounds. These sounds are combined at the next-higher level (2) into the utterance of meaningful words. These words then (3) achieve further meaning by our dwelling in them in order to integrate them into the sort of meaning that only sentences can have. Sentences themselves are then (4) worked together into a style or mode of creating impressions or intelligible points--something that does not exist in sentences as such. Finally (5), the style or mode of creating impressions must itself be used (dwelt in) toward the attainment, through it [their italics] of the ideas or results that are the focal aim of the communication.[6]

They go on to point out that each level is controlled not only by its own principles but also by those of the "next-higher level."

> The voice you produce is shaped into words by a vocabulary; a given vocabulary is shaped into sentences in accordance with a grammar; and the sentences are fitted into a style, which in its turn is shaped by our efforts to convey the ideas of the composition.[7]

Much the same seems true in the performance of a complex mechanical skill. At the lowest level undisciplined muscle movements are transformed into refined motor skills such as tightening and loosening nuts and bolts, screwing screws, manipulating objects in inaccessible places, and so on. These refined motor skills are chained together at the next-higher level into larger sub-operations such as removing, installing, disassembling, or assembling various vehicle components. At a still higher level of performance these sub-operations are integrated into comprehensive procedures for making complete repairs of components; and these, when necessary, are merged into an overall systems strategy to handle problems that overlap component systems.

Like the production of oral communication, each level in the performance of a mechanical operation is subject to the organizing principles of the next-higher level, which rework it to serve the higher purpose of that level. For example, the uncoordinated motions of muscles are converted into precise motor responses in accordance with physical laws governing the use of simple hand tools. The subsequent coordination of motor skills into meaningful sequences of activity (the suboperations) is patterened by mental blueprints of each component, which detail its construction and dictate the order in which it should be dismantled or put back together. Passing beyond the mere assembly or disassembly of a component to effect its actual repair requires, in addition to a mental blueprint, an intensive knowledge of what it does, the malfunctions to which it is subject, and how those malfunctions can be corrected. Finally, a malfunction that transcends a single system and appears to implicate several different components requires an overall conception of the vehicle and its interrelated systems in order to formulate an effective diagnostic strategy.

What Skills Do Apprentices Learn?

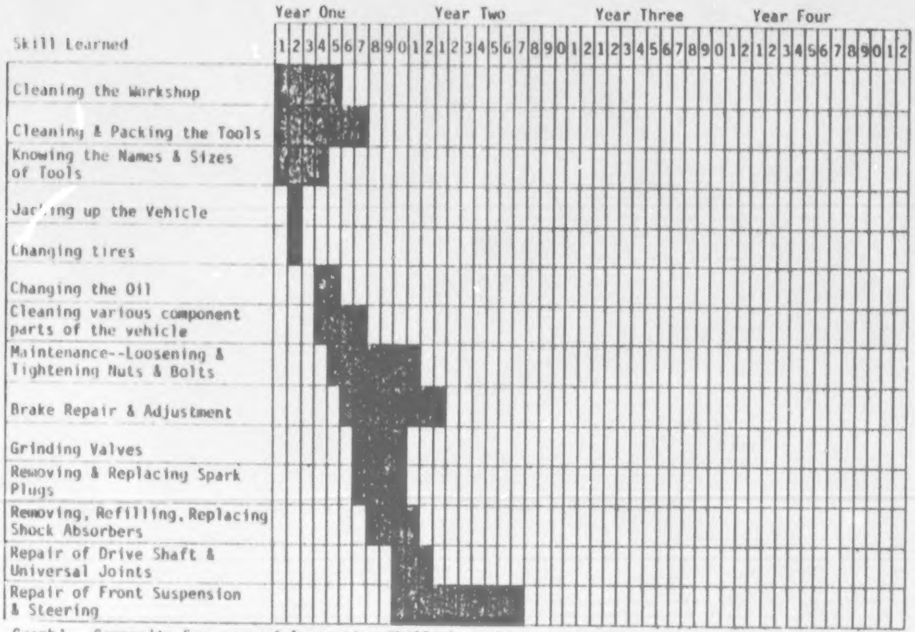
The foregoing conceptual framework now makes it possible to examine with some clarity the question of what apprentices learn during their training. To review briefly the discussion about methodology in Chapter I, three methods of obtaining data about apprentice skill acquisition were employed in this study. One method was to observe the skills apprentices use while they are working on actual repair jobs in the workshop. A second method was simply to ask apprentices during an interview to list the skills they had learned. A third method was to administer a formal skills test to determine which skills they possessed. Although in some respects the first method of observing apprentices at work was the preferred approach, it was unrealistic for the researcher to make any highly technical judgements about the competence of apprentices in performing their work. Therefore, this method was used more as an exploratory tool while the latter two were relied on for the more systematic data. Of these two, the information solicited from the apprentices themselves is the more impressionistic and for that reason is considered first.

A total of thirty-four apprentices and seniors were asked to specify the skills they had acquired or were in the process of acquiring during their apprenticeships. This question was administered by presenting each apprentice with a series of cards on which a number of different repair skills (often stated as a complete repair job--e.g. repair of the carburetor) were written in English. The cards covered the repair, replacement, or maintenance of all major components in a motor vehicle. These repair skills/jobs had been gleaned from many observations of workshop activity and discussions with master mechanics in wayside workshops.

The apprentice was first asked to declare if he had in fact actually worked on each of the repair skills (as opposed to observing others work on them). He was asked to separate the cards that listed repairs he had worked on in some capacity from the cards listing repairs he had never worked on. He was then asked to arrange the first set of skill cards in the order in which he first began to learn the skills. At one end of the sequence would be the card of the first repair skill or activity that he had learned, while at the other end would be the card of his most recently learned skill. The apprentice was then asked to go back through this sequence and determine how long it took to learn each repair skill so that he could perform it without assistance from a more experienced apprentice or the master. A different procedure was used for illiterate apprentices. In this case a co-worker asked the apprentice to recall in order the skills he had learned in his apprenticeship, prompting him whenever necessary by mentioning skills he may have overlooked.

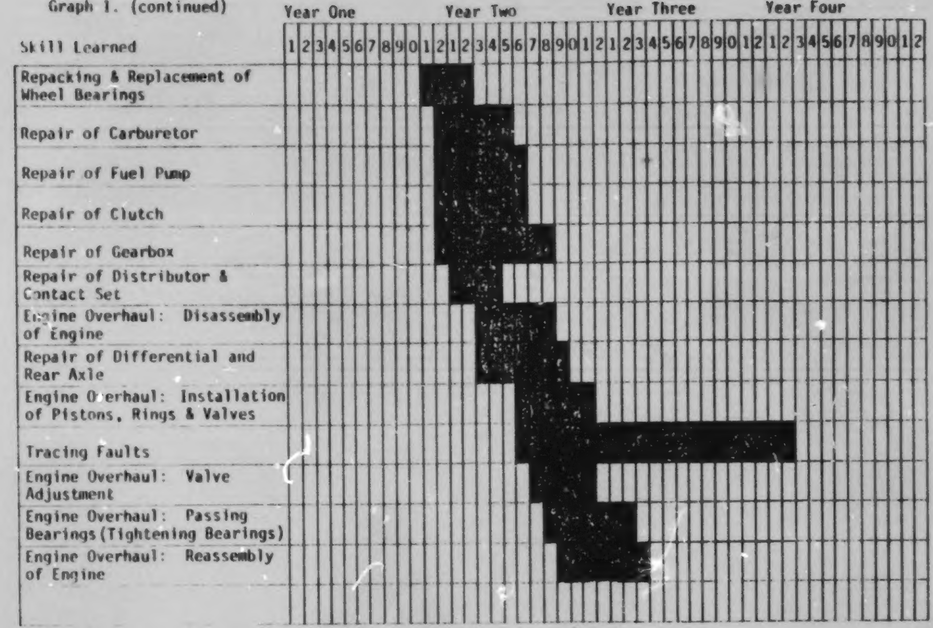
Apprentices frequently had remarkable memories of exactly when they had first begun to learn particular skills. Although they were less certain about when they had become competent in making a complete repair, apprentices generally had a reasonably accurate recall of both the content and sequence of their skill learning experiences.

In order to analyze these individual reports of skill acquisition as a collective learning experience, the data from individual apprentices were compiled into a series of aggregate figures and displayed in a composite graph found in Graph 1. Each bar on the graph signifies a particular repair skill learned during the five years that most apprentices spend in the workshop. The beginning and ending lines of the bars denote, respectively, the time at which the learning first began and the time when the skill had been learned so well that no outside assistance was required. The length of the bar denotes the time that was taken to



Graph1. Composite Sequence of Apprentice Skills Learning.

Graph 1. (continued)



learn the skill. This composite graph represents the content and sequence of the training experience for the 34 apprentices and seniors as a whole and is, in this researcher's opinion, fairly typical of the skills learning process in wayside workshops throughout Ghana. As such, it constitutes a kind of "curriculum" of the wayside mechanics apprenticeship in Ghana.

The composite results shown in Graph 1 tend to corroborate the conceptual framework of skill acquisition proposed earlier. The easier repetitive skills and simple maintenance skills are learned at or near the beginning of the apprenticeship.[8] After six months in the workshop apprentices begin to try their hand at some of the less difficult repair/replacement jobs, such as brakes, spark plugs, shock absorbers, universal joints. Gradually, they begin to tackle the repair of some of the more complex components which take longer to fully master: for example, the front suspension, steering system, carburetor, fuel pump, clutch, and gearbox.[9] After about 15 months to a year and a half in the workshop apprentices begin to work on the engine itself, regarded by Ghanaian mechanics as the most difficult aspect of their trade to learn (the skills associated with engine work are depicted on the graph as separate sub-operations of the engine overhaul). Their belief would seem to be confirmed by the fact that full mastery of engine overhaul skills requires anywhere from six months to a year after the first active exposure to the engine.

The first attempts at fault diagnosis are made about halfway through the second year and learning of these skills continues for more than a year and a half; longer than for any other skill. In spite of the appreciation that apprentices frequently express for the difficulty of fault diagnosis, most of them seem to have grossly overestimated the sophistication of their own diagnostic skills. It would be unusual indeed for an apprentice mechanic to gain full command of this higher domain of skills without either considerable formal training or much longer experience in the workshop.

By their own assessments, apprentices commit the first three years of their apprenticeships to achieving at least nominal qualifications as mechanics. At the end of this period when they formally terminate their apprenticeship status, they fully expect to be competent in doing most of the repairs that come into their workshops. There is little indication from any specific data presented here about which skills and knowledge are learned during the following two years, when most apprentices remain in the workshops as seniors. The general impression given by masters and seniors is that seniors use this period to consolidate and extend their basic skill repertoires while they are being exposed to such entrepreneurial matters as dealing with customers, collecting repair bills, assuming responsibility for the overall quality of repair jobs, supervising the work of younger apprentices, and procuring parts from spare parts dealers.

Although skill training in the wayside workshop has been characterized as random and discontinuous, the evidence from these results suggest that it is far from being chaotic. While no formal instruction is given nor any pre-conceived format followed, there is, nonetheless, an implicit order to the entire apprenticeship experience.

In part, this order originates from the apprentices themselves with their realization that it is wiser for them to learn easier skills before trying to learn difficult ones. Mostly, however, it proceeds from the way the jobs themselves are allocated. The master, whose main concern is getting the work done quickly and correctly, is well aware of the varying abilities of his workers and therefore assigns them to the jobs accordingly. By assigning competent workers to each job, the master, in effect discourages unqualified workers from attempting to learn--except under close supervision--tasks which are beyond their ability. Such economically-inspired considerations thus become a kind of imposed ad hoc structure on what is otherwise a decidedly laissez-faire mode of learning.

The Assessment of Apprentice Skill Competence

The skill profile that has just been presented provides only a partial picture of skill acquisition in the wayside workshop. It describes rather explicitly which skills apprentices learn and when they learn them. As was suggested earlier, however, there is some reason to suspect that apprentices are not always the best judges of what they know and can do. It was therefore necessary to find out why they actually do know by other means.

The formal skills test was used for this purpose. It has already been stated in Chapter I that the test used in this study was a verbal test designed to measure a worker's knowledge and skills in mechanics no matter what make of car or truck he was used to working on. In other words, it was intended to test mechanical knowledge and skills that apply universally to all motor vehicles. Although practical skills can be assessed more accurately through direct observation of activity, a verbal test was necessary in this case because it did not require assembling large amounts of equipment. However, a few items of equipment were used as the basis for some questions, among which included a piston, a distributor, spark plugs, nuts and bolts, and a few photographs.

The skills test (see Appendix H) was structured in such a way that it would indicate a worker's competence in each of the three skill levels. Consequently, there were three classes of test items: (1) some which tested knowledge of simple repetitive skills; (2) some which tested identification, knowledge, and repair of various vehicle components; and (3) some that tested an overall systems grasp of the motor vehicle, including fault diagnosis techniques. Although a verbal skills test has the inherent drawback of only indirectly measuring skill competence, a detailed verbal knowledge of equipment and repair procedures does at least demonstrate an intimacy with the repair work--if not the possession of the actual skills themselves.

A word of caution is in order in interpreting the results of this skills test. While the test was administered as systematically as possible, it was not modeled after a conventional experimental design. For example, only eighteen workers in four workshops were tested; a conspicuously small sample of the total population of wayside workers in Koforidua. The sample was also not selected by a random procedure. Instead, an effort was made to include for testing workers representing widely different lengths of training, although, unfortunately, those with only very brief experience in the workshop were not tested. Because of these limitations, it will perhaps be difficult to draw any broad conclusions about skill competence for all workers in wayside mechanics workshops. The results of the test do, however, highlight some of the general characteristics of skill proficiency among wayside mechanics.

Skill Test Results. Table 9 contains a list of the eighteen workers who were tested, their status, their workshops, their length of training experience in mechanics, their years of schooling and their age. Table 10 contains a list of the same workers along with their results on the three levels of the test and their total score. The two questions of Part II of the skills test were not tabulated with the other questions but were analyzed separately.

Notice that for the first 11 workers there seems to be no discernable pattern of improvement in test performance linked to length of training. But for the workers with 42 months or more of experience there is a consistent range of higher scores anywhere from 4 to 15 points above the best total score of the less experienced workers. These higher figures are particularly noticeable in the Level II and III questions. In keeping with the rationale of the skills test, the results suggest that the mechanical knowledge and skills of very experienced workers are significantly more advanced than those of less-experienced workers.

The most obvious explanations for this superior test performance of older apprentices and seniors is that it is purely a consequence of their longer experience in the workshop. However, more than the

TABLE 9

WORKERS TESTED

Name of Worker	Status	Work-shop	Length of Experience*	Years of Schooling	Age
1. Kwaku Frimpong	A	AK	21 months	2	17
2. Kobina Ezeh	A	MM	21 "	10	19
3. Robert Nyavo	A	AK	21 "	10	19
4. Daniel Boateng	A	MM	22 "	10	20
5. Prince Aggrey	A	AY	24 "	10	20
6. John Afedu	A	AK	25 "	10	19
7. Samuel Koranteng	A	AY	26 "	10	18
8. Yaw Kumah	A	AY	29 "	9	22
9. Atta Owusu	A	AK	30 "	10	23
10. Victor Datsumo	A	AK	35 "	10	24
11. Kwesi Asiedu	A	AK	38 "	8	22
12. Atsu Ayitey	A	MM	42 "	10	24
13. Kodjo Kwao	A	FS	43 "	10	22
14. Anthony Dakpo	A	AK	48 "**	11	18
15. Jonathon Addo	S	AK	57 "	10	19
16. Charles Abgoku	S	AY	62 "	7	20
17. Alphonse Twum	M	MM***	70 "	10	26
18. Enyo Komle	S	AY	86	4	20

*Lenth of time subject has worked in a wayside mechanics workshop, beginning with the first day of his apprenticeship.

**Part-time apprentice during after-school hours and vacation periods.

***Independent master sharing workshop site with Samuel Asumanu. Former Apprentice in Akan workshop.

Code:
AK - Akan
AY - Ayigbey
FS - Friendship
MM - Modern Motor

A - Apprentice
S - Senior
M - Master

TABLE 10

SKILLS TEST RESULTS
Part I

	Name	Length of Experience	No. of Questions Correct* Level I	Level II	Level III	Total
1.	Kwaku Frimpong	21 months	15	22	4	41
2.	Kobina Ezeh	21 "	16	32	5	53
3.	Robart Nyavo	21 "	15	34	5	54
4.	Daniel Boateng	22 "	16	26	5	47
5.	Prince Aggrey	24 "	14	34	9	57
6.	John Afedu	25 "	18	33	7	58
7.	Samuel Koranteng	26 "	14	35	8	57
8.	Yaw Kumah	29 "	16	31	7	54
9.	Attu Owusu	30 "	16	32	5	53
10.	Victor Datsumo	35 "	19	25	8	52
11.	Kwesi Asiedu	38 "	17	15	5	37
12.	Atsu Ayitey	42 "	14	45	5	64
13.	Kodjo Kwao	43 "	18	38	9	65
14.	Anthony Dakpo	48 "	10	42	12	64
15.	Jonathon Addo	57 "	17	44	12	73
16.	Charles Agboku	62 "	19	42	8	69
17.	Alphonse Twum	70 "	19	43	7	69
18.	Enyo Komle	86 "	16	36	10	62

*Out of a possible:
a) 24 (Level I)
b) 58 (Level II)
c) 15 (Level III)
97 (Total)

additional time alone, it may be a combination of factors that accounts for the difference. For example, one quality that the more advanced workers (except Anthony Dakpo) share in common besides their greater experience is the considerable responsibility entrusted to them in the workshop. Masters for the most part regard these workers as competent mechanics, to whom they can confidently turn to discharge important duties such as supervising other workers and undertaking complete repair jobs. Alphonse Twum, one of the tested workers who happens to be a young master and workshop head, is probably even more accustomed than the others to the demanding roles and obligations that accompany full professional status.

The precise effect of these responsibilities on learning is, of course, a matter of conjecture. But few experiences are capable of consolidating one's skills quite so quickly as being placed in the position of having to teach one's skills to others and accept responsibility for their success or failure in learning them. The responsibilities that go along with their mature status, coupled with their long exposure to the mechanics work, no doubt play a major part in determining the more extensive mechanical knowledge and skills of experienced workers.

Unfortunately, not much can be said about the effect of years of schooling and literacy on mechanical competence from these test results. Masters usually insist that formal education has little or no bearing on a worker's skill competence and that unschooled, illiterate apprentices are just as likely to be among their most skilled workers as those with several years of schooling. However, lack of literacy in English may have an effect to the extent that it can alter the role of the apprentice in the workshop. For example, some tasks in the workshop, such as purchasing spare parts from dealers in Accra, require that the person making the purchase know the names of the specific parts in English. As a result, apprentices who are illiterate in English are frequently not assigned such tasks.

Enyo Komle, one of the seniors in the test sample, is a case in point. With just four years of formal schooling, Komle can neither read, write, or speak English, although he is literate in his own native Ewe language. After seven years as an apprentice and a senior, he is the most experienced worker in his workshop (with the exception of his master) and one of the most experienced mechanics in Koforidua, among those still working in their masters' workshop. With this depth of experience, one might expect Komle to be employed in a large government or commercial workshop, operating his own wayside workshop, or at least holding an authoritative position in his master's workshop. Yet, he still works as one of several ordinary seniors in his master's workshop. Apparently because of his young age and his lack of English language skills, his master has passed over him on at least one occasion to select a somewhat less experienced (but older and more educated) senior to serve as the Workshop Assistant; a position that entails considerable responsibility to supervise workers, deal with customers and purchase spare parts. As one of the seniors, he does possess some responsibility--but certainly far less than he would have enjoyed had he been chosen Workshop Assistant.

While it would be speculative to assume in this case that Komle's test performance was ultimately impaired by his very limited English and formal educaton, it is safe to say that language skills and formal schooling in general are not without some--and perhaps considerable--impact on skill development, either by themselves or in interaction with other variables of the workshop environment. But the exact effects of these factors as well as the mechanisms by which they help to shape skill competence will have to await the outcomes of more focused future studies.

Formal instruction in motor mechanics appears to be another factor contributing to the higher test performance of one worker. The results of Anthony Dakpo, who scored in the higher range of the seniors, can possibly be attributed as much to his course of instruction in school as to his apprenticeship experience. Dakpo is presently a full-time student in a technical secondary school where he studies motor mechanics. Although he is listed as an apprentice with forty-eight months experience, his actual working time in the workshop is far less, since he works only part-time during after-school hours and vacations. His score on the Level III question, along with that of Jonathon Addo was the best of the entire group, reflecting the essentially theoretical orientation of his school instruction. He himself often alludes to the relative ease with which he can diagnose faults in equipment and yet not be able to correctly dismantle and reassemble certain components. Not unexpectedly, his score on the Level I questions was the lowest of the entire group tested. For example, he answered incorrectly all ten of the questions on estimating the sizes of nuts and bolts; a relatively simple skill that normally evolves after lengthy practical experience. In a sense, Dakpo's results merely affirm an oft-held belief among Ghanaian mechanics that technical schools teach the theory of motor mechanics while wayside workshops teach the practical repair work.

Theoretical Knowledge. One of the most important issues investigated by this study is whether or not wayside workers have a theoretical knowledge of the mechanical equipment they work on every day. Some of the questions in Part I along with the Part II questions (see Appendix H) were intended to probe that theoretical knowledge. Question 1 in Part II is particularly revealing in this respect. Here the worker was asked to explain how the internal combustion engine operates. Although his answer was brief and contained an inaccurate firing order, Anthony Dakpo was the only worker tested who seemed to have a relatively clear idea of how an engine works:

> The petrol is burned by the ignition system. There is a firing order for the ignition system. When the car is sparked, the #1 piston does induction, the #2 does compression, the #3 does the power stroke and the #4 does exhaust. The crankshaft turns as a result of the burning of the gases and the forcing of the piston down.

In contrast, some workers had a very confused notion of engine operation. The following answer by the apprentice Prince Aggrey is typical of their thinking:

> The compression comes when the pistons compress to the cylinder head. The crankshaft turns and makes the pistons go up and down. The flywheel makes the crankshaft turn. The fanbelt turns the flywheel and the puller turns the fanbelt.

The stumbling block of many workers to understanding engine operation appears to be a failure to comprehend the principle of energy transfer. The principle could be stated as follows: the burning of the gasoline-air mixture within the cylinders causes the mixture to expand rapidly and drive the pistons in a reciprocating motion which, in turn, is converted into a rotary motion by the crankshaft. Except for Dakpo, none of the workers managed to clearly articulate this fundamental concept.

Moreover, many had a similar conceptual difficulty with the four strokes of the engine and the coordinated movements of pistons and valves (see questions 84-87 in Part I). None of the workers, except Dakpo (who was the only one to answer all four questions correctly), knew the proper alignment of pistons and valves for the all-important power stroke, which is the key to the operation of the internal combustion engine. To convert the energy of combustion into useable mechanical energy, the cylinder must be tightly sealed during combustion to allow the expanding gases to be directed against the moveable piston with full intensity. Obviously, any unintended opening or leakage in the combustion chamber at that moment (as caused, for example, by both valves not being closed) will allow an easy escape route for the gases and quickly dissipate that energy--a concept that only one worker seemed to grasp with any certainty.

The ignition system seemed to pose problems of comprehension as well. Questions 51-58 in Part I asked workers to name the component parts of the ignition system. Without having memorized these components, one could figure out the answer by considering the larger question of how the fuel-air mixture is so precisely ignited within the engine cylinders. An answer to this latter question will in effect "point to" the components of the ignition system, as illustrated in the following: a circuit is closed (by the ignition switch) permitting a timed electrical impulse of sufficient strength to be generated (by the breaker points, coil, and condenser), directed (by the rotor and distributor cap), and transported (through the high tension leads) to the correct cylinder where a spark is produced (by the spark plug) to ignite the fuel at the right moment Although most workers were able to name a few of the ignition components, only one, Atsu Ayitey, came close to naming all of them. Such poor results seem to indicate that workers had no broad, systems conception of ignition from which to draw specific factual information.

The set of questions about the distributor (questions 59-70) is yet another example of the important role of theory in deducing specific answers. A case in point is question #70 concerning the function of the vacuum advance unit: a small device on the distributor that advances the timing at higher engine speeds. For this question, it is helpful to know the effect of a vacuum in the intake manifold in order to know why the distributor timing must be advanced. Although a few workers knew that air passes back and forth inside the hose connecting the carburetor and the vacuum advance unit, none of them apparently knew that this air movement was a response to changing vacuum conditions in the engine. As a result, none of them could accurately state the function of this device, although two workers

(Jonathon Addo and Atsu Ayitey) did give acceptable answers. But even their answers were technically imprecise ("Air passes from the carburetor to help the engine run quicker by making the points open more").[10]

Equally imprecise answers were given for the question about the function of the breaker points (#67). Many of these answers were along the following lines: "They make the fire"; or "It gives fire to the engine", or "This is the fire." The answer given in Appendix I is a far more accurate statement of the function of the breaker points. In spite of their ambiguity, though, the above answers were scored as correct since it was assumed that the workers probably had the right idea. The term "fire" is a very typical, although vague, expression that Ghanaian mechanics use to describe the high voltage charge of the ignition system. Functionally speaking, they are correct. The spark is literally a tiny fire that ignites the fuel. But the exact mechanism by which this "fire" is produced in the motor vehicle appears to be something of a mystery to them.

Fault Diagnostic Ability. The answers to the fault diagnosis question (see question 2 in Part II) shed some additional light on the theoretical knowledge of wayside workers. Unlike the Part I questions, the more elaborate answers here are difficult to quantify and display for comparison. However, they can be analyzed on several criteria: for example, on the number of potential faults identified and the relevance of the faults to the specific malfunction; the number of confirmatory tests cited and the probable accuracy of the tests in separating faults with nearly identical symptoms; and the overall economy of the suggested diagnosis in terms of the time and labor that would be spent executing it.

As in the results for Part I, very experienced workers did appreciably better than less-experienced workers, suggesting that longer work experience leads to an improvement in diagnostic ability. Many less-experienced workers simply enumerated all the faults and tests they could think of--which were not many in most cases--with little regard for whether or not they applied to the malfunction at hand. The following examples are the answers of Kwaku Frimpong and Robert Nyavo.

Example #1--Kwaku Frimpong

> First check the coil and battery wires and the distributor. For the coil maybe some of the wires are broken.
>
> When the contact set (points) is closed it won't spark. Check by turning the rotor by hand to see if the contact set opens properly. If it doesn't open you turn the engine to #25 (a degree mark) and remove contact set and clean and fix it back.
>
> If the car still doesn't spark (start) you open the carburetor and see if there is dirt in it.
>
> You can check the fuel pump. If dirt goes inside it won't work. So you remove it and see it pumps properly. You pump it by hand and see if fuel comes through the pipe leading from the fuel tank to the pump. If you fix it back after working on it, then the car will start.

Example #2--Robert Nyavo

> The contact set or plugs could be bad. If the plugs are bad you won't get quick spark. Check the plugs and contact set and also check the carburetor to see if the petrol is coming.
>
> You can open the ignition key and check with a screwdriver to see if contact set is making light. If there is no spark, you can remove it and sandpaper it and make it smooth. Then fix it back. If you put a screwdriver and

> you still don't see a spark, you know the timing is no good. You check the timing. Checking the timing is the only thing you can do by then.
>
> You can check the plug wires and coil wires and see if they're in position. By checking the wires I think you'll get spark across the points.
>
> As for the plugs, I've already said it. You replace the plugs. If you remove a plug and you see it has water in the end, you know it's no good. So you replace 4 new ones.
>
> You see whether there's petrol in the tank. If there is petrol in the tank, then you know there is a fault in the engine. The head gasket can be burnt and water can be going to the valves or the valves can be burnt. You remove the head and see what is going on.
>
> If there is no trouble in the head, you can see if it's a problem with the bearing on the crankshaft. You do overhauling.

They often listed totally irrelevant faults (e.g., "If the oil pump doesn't turn, the valve tappets will not be lubricated and the car will not start."). When they did manage to cite relevant faults and tests, they frequently arranged them into a very uneconomical diagnostic procedure (as, for example, in recommending the removal and dismantling of the fuel pump before checking to see if fuel is in the tank). Another mistake that such less-experienced apprentices often made was to misinterpret the data from certain tests (e.g., saying that the breaker points are faulty if no sparks are produced when they are opened manually with a screwdriver).

More experienced workers, while far from being immune from such mistakes, generally listed more of the relevant faults, supplied more details about administering tests, and recommended somewhat more systematic and complete diagnostic strategies than their less-experienced counterparts. The following answer of Jonathon Addo is an example of this more systematic and comprehensive approach to trouble-shooting.

Example #3--Jonathon Addo

> Maybe the fire is not coming to the ends of plugs or petrol is not reaching the carburetor. You open the distributor and rotate the rotor by turning the crankshaft pulley to see whether the contact set opens. Open the ignition (turn ignition on) and see if fire comes across the points.
>
> If there is fire, you should check the coil to see if it's in good condition. You open the ignition and loose the positive wire from the coil to the side of the distributor and brush it against any part of the engine block to see if fire is there. If there is fire reaching the coil then you must remove the contact set and clean the points. If there is no fire then the coil is no good and you remove the coil and replace a new one.
>
> If after cleaning the contact set it still doesn't spark, you check the wires or the ignition to see if there's a loose wire.
>
> If the car still won't spark, you remove a plug, attach the wire to the plug and spark the engine while putting the plug on any part of the engine. You look for the fire at the ends of the plugs. If there is no fire, check the wires from the coil to the distributor cap and from the distributor cap to the plugs. See if the wires are tight.
>
> If fire is coming you go to check the fuel system. You check if fuel is coming into the carburetor. Push the accelerator to see if petrol is coming in. If no petrol is coming, you must open the top of the carburetor and see what is wrong. Maybe there is no petrol in chamber or dirt has gone into the pumping jets.
>
> If the jets are clean, you should check the fuel pump by pumping the diaphgram by working the pump attached to the fuel pump by hand. If the diaphragm is working, petrol will come into the chamber. If the petrol is not coming into the carburetor, then remove the fuel pump and check the diaphragm and see if it's torn or if air is leaking at the place.
>
> If the fuel pump is alright and petrol still doesn't come, then there's dirt in the pipe leading from the tank to the fuel pump. You blow air through the pipe to see if air is passing through. If petrol still doesn't come then there is no petrol in the tank. But you should check for this at first.

> If these things are working and the car still doesn't spark, then it means petrol is too much on the piston and is overfloating (flooding). For overfloating, take off the plugs and spark it and don't operate the accelerator to allow all petrol to come out.
>
> If it still doesn't spark, the timing of the camshaft is not good. Open the valve cover. Turn the engine to where you usually time it and check to see if the rotor is lined up to the timing mark. The cam must also be on the mark. If the cam is not on the mark, then the timing chain may be loose--check the timing chain. If the rotor is not pointing correctly, then you remove the distributor and reset the timing gear before putting it back.
>
> There is nothing again which can cause it not to spark. Poor compression will allow it to spark but not to work well.

It is uncertain whether additional experience beyond the seniorship period further improves diagnostic ability in the absence of any formal training. Two very experienced master mechanics (George Adumoka and Samuel Asumanu) to whom the diagnostic problem was informally administered did not give significantly more elaborate diagnostic strategies than the most experienced seniors. However, in view of their long experience, it is possible that they did not verbalize much of what they know and may actually have a wealth of situationally-specific knowledge at their command.

Conclusions. The skills test on the whole, although not conclusive, does strongly favor the conclusion that wayside apprentices and seniors (and possibly many masters as well) generally possess little more than a superficial knowledge of motor mechanics theory. Workers seemed to have difficulty clearly explaining some of the fundamental operations of the very machines they repair. They were often unable to give accurate information about the functions of basic components. In locating faults, they tended to concentrate mainly on the most familiar faults and the simplest of tests. Although a few of the most experienced workers had the beginnings of a systems approach, the diagnostic procedures of the others could hardly be characterized as systematic.

The evidence for arriving at this conclusion is not limited to formal data alone. The conclusion is also borne out in much informal observation of wayside workers and personal testimony from mechanics instructors and others who are familiar with the repair practices of wayside mechanics. Much of this informal evidence is, of course, diffuse and subjective--but it is telling nevertheless, as these few short excerpts from field notes will confirm:

> --Two young apprentices busily grind the valves on an engine to be overhauled, but have no idea of why the valves need to be ground. They are eager to learn the purpose of such an activity so it will not seem so pointless and mysterious to them.
>
> --The apprentices reassembling an overhauled engine chafe at their master's insistence that they carefully clean all minute metal particles from the cylinder walls before reinstalling the pistons. They seem to have little awareness of what effect such particles would have on the working surfaces and compression of the cylinders.
>
> --Wayside mechanics often adjust the valves of engines with no particular pattern instead of according to the firing order, which would insure that the valves are in a known position.
>
> --Many mechanics, both experienced and inexperienced, have no appreciation of the importance of regular preventive maintenance (change of oil, lubrication, etc.) and perform such maintenance only after long intervals.[11]
>
> and so on.

The Functional Competence of Wayside Mechanics

After what has just been said, it might seem to some as if wayside mechanics are rather ill-equipped to practice such a technical trade. Without a basic understanding of motor mechanics theory they would seem to be seriously handicapped in effectively repairing such complex machinery. But it would be unwarranted to assume from the results of the skills test that they are inept at their work. To say the least, the average wayside master and his cadre of workers are competent enough to satisfy their customers and maintain a financially-viable (at least marginally) business--no small comment on the competence of any tradesman. In nearly every wayside workshop, any of the very experienced workers are able to make commercially-acceptable repairs on all types of malfunctions despite their meager theoretical knowledge. Yet, the question remains of how such practical competence can develop independently of sound theoretical understanding.

To handle the repair jobs that he encounters every day, each wayside worker regardless of experience draws on a personal repertoire of skills and knowledge that is specifically tailored to the tasks he must perform. This repertoire represents the sum-total of his experience in the field of mechanics, whether he is an apprentice of one month of a master of thirty years. The repertoire is therefore a reflection of what the worker can do at his level of experience. While a young apprentice may be capable of only a few repetitive routines, an older master is likely to have an exceedingly vast array of higher skills at his command.

The skill repertoire appears to be built up cumulatively as the worker grapples repeatedly with the same repair problems. From countless instances of working on a particular repair he gradually learns the many disparate motor skills, perceptual habits, and task-related knowledge needed to make the repair. In time he moulds them all into a coherent repair operation that enables him to take future responsibility for the complete job. This pattern is repeated as he progresses from simple repair problems to more difficult ones. The eventual accumulation of many such operations that are acquired while handling a broad range of jobs constitutes his entire skill repertoire.

At first glance, this appears to be a classic (if rather laborious) example of inductive learning. Just as induction proceeds from the particular to the general, so does this learning begin with rudimentary skills and move inevitably towards more abstract constructs of automotive machinery and its repair. However, unlike classic induction, the learner in this case never seems to arrive at any general principles of mechanics. Instead, the outcome of his learning appears to resemble something midway between basic manual dexterity and over-arching theory--a kind of functional capacity to effectively repair a large, but finite, number of specific malfunctions.

The functional nature of his competence undoubtedly has a lot to do with the way the wayside mechanic goes about his work. When tackling a repair problem, he is forced to rely heavily on the methods he used in the past to make similar repairs. Often he instinctively recognizes the fault by comparing the symptoms of the present malfunction to his past associations with those symptoms, after which a reliable repair procedure is applied to correct the fault. But the methods that worked well in the past are not necessarily applicable to each new problem. While he will very likely have good success in diagnosing any familiar fault, he may well fail to solve a repair problem that exhibits the familiar symptoms but is caused by an unfamiliar fault. As Tilley points out, the diagnostic proficiency of an experienced mechanic may be very highly developed, yet still limited in that it consists of only "a larger repertoire of previously encountered faults rather than a generalizable method of analyzing a problem."[12]

Because motor vehicles operate according to rational laws of probability, they are just liable to occasionally turn up with an obscure fault. Even the most gifted and experienced mechanic periodically meets a fault that is unusually elusive or intractable; perhaps a fault he has never seen before. It is precisely in these situations that the possession of theoretical knowledge can be an invaluable asset to the mechanic. When all the familiar remedies are of no use there is at least the possibility that a solution to the problem could be deduced from general principles.

Theoretical knowledge of motor mechanics can also assist the mechanic to make acceptable repairs of a wide variety of components and vehicles, in spite of the inevitable differences in design and construction. For example, if a mechanic understands the seven basic systems or circuits of a carburetor, he should be able to figure out how to repair any carburetor--even one which is totally foreign. Curiously, their lack of such general knowledge may account in part for the widespread tendency of wayside mechanics to specialize in one or two makes of vehicles. The effect of limiting their practice in this way, of course, is to minimize the inter-model variations that they would have to be competent to handle. With such specialization they can then confidently claim to be experts in repairing the few models that they do accept.

At those not uncommon times when a repair problem goes beyond the domain of familiar practice, wayside mechanics in particular are often at a loss since they not only have no ready solution to the problem in their skill repertoire but also little means of devising a successful one heuristically. It is in such situations that one begins to see the signs of inefficient and inferior quality work from these artisans: the excessive amount of time spent trying to diagnose a fault or even the return of a vehicle to its owner without the fault being corrected; the creation of a completely new problem in the process of "fixing" the old one; or the attempt to locate a fault through the random replacement of components until the defective one is finally found, at considerable expense to the owner. Although this same incompetence does exist among the less well-trained mechanics in the West, it is so pervasive among Ghanaian wayside mechanics to be symptomatic of a serious indaequacy in their professional training.

The Art of Improvisational Repairs

No analysis of skill learning would be complete without some mention of the remarkable improvisational skills of wayside mechanics. Their sometimes ingenious improvised repairs made in seemingly hopeless situations epitomize their unique contributions to the transportation industry and earn them the special esteem of many drivers and vehicle owners. While some see the wayside mechanic as a poorly-trained illiterate who mixes crude tools with shoddy practices, others see him as a truly creative craftsman with an extraordinary capacity to survive--even thrive--under conditions that would thoroughly frustrate a more systematic mechanic.

The ability of wayside mechanics to fashion improvised repairs is in part a spin-off from their practical, hands-on training and their lack of formal instruction in mechanics theory. More importantly, however, it is their own instinctual response to the uncertainties within their trade; their way of coping with the acute shortage of spare parts in the country and the heavy capital outlay needed to buy tools and equipment. For most wayside mechanics, improvised repairs are a matter of survival. When no spare part is available or is available only at an intolerable price, the mechanic is left with a clear choice: either allow the broken-down vehicle to remain out of repair until the part becomes available; or make a repair that may not be conventional or even acceptable by textbook standards, but which puts the vehicle back on the road. As one wayside mechanic succinctly put it, "You have to wrack your brain till you find a solution or you won't make a living at all from your work."

The wayside mechanic must function with a deficiency of tools and equipment as well as spare parts. Almost to a man, they are not equipped with many of the most basic tools and test instruments which a Western mechanic would deem essential to perform his craft. Where the wayside workshop may have only the more frequently used wrench sizes and a few all-purpose tools such as hammers, chisels, files, crowbars, and punches, the average Western garage would have a full range of wrenches of different types, specialized pliers, screwdrivers, pullers, extenders, torque wrenches for nearly every purpose, as well as a complement of electronic testers, strobe lights and perhaps an oscilloscope. This wide assortment of tools and equipment allows the Western mechanic to perform his job both more quickly and more accurately.

The wayside fitter adapts to shortages of tools and parts by using what little he has and making it work. As a hedge against the occasions when he cannot obtain a vital spare part, he stores in his workshop all manner of old parts, both large and small, functional and beyond repair--even the rusted hulks of ancient vehicles, never to run again. He also often works in close conjunction with a welder or a blacksmith, who can often turn out functional replacements of certain parts and even a few tools. And for other parts such as shafts and bushings which require more precise machining, he relies on the craftsmanship of the local machine shop to fashion custom-made substitutes.

Claude Levi-Strauss attempted to characterize this so-called "primitive" artisan and his "sciences of the concrete" by drawing on a parallel in French culture.[13] In France, there is a figure known as the bricoleur, or the handyman, who approaches his work in much the same way as the wayside mechanic. When faced with a task, the bricoleur, like the wayside mechanic, first considers the situation and assesses the materials and tools at hand before setting out to improvise a specific solution to the problem. In Levi-Strauss' terms:

> The 'bricoleur' is adept at performing a large number of diverse tasks; but, unlike the engineer, he does not subordinate each of them to the availability of raw materials and tools conceived and procured for the purpose of the project. His universe of instruments is closed and the rules of his game are always to make do with 'whatever is at hand'. . .[14]

The bricoleur and the improvising mechanic both accomplish their tasks by reorganizing these old elements into a new arrangement, which somehow renders the completed project (in the case of the mechanic, the repaired vehicle) different from its original state. As one interpreter of Levi-Strauss put it:

> . . . the bricoleur begins with the event--the broken machine and the tools available--and attempts to build a structure--a set of operations with the tools which will repair the damage.

The scientist or engineer (and, presumably, also the formally trained mechanic), on the other hand,

> . . . begins with the structure--his knowledge of the intact apparatus, his deductions about possible flaws --and then gradually converges upon the event--the specific tools and actions needed to repair the damage.[15]

Although this comparison with the bricoleur does not sufficiently recognize the more systematic side of wayside fitters, it is a useful metaphor to keep in mind when examining their impressive improvisational talents.

There are many different kinds of improvised repairs that wayside mechanics make. For example, there are modifications of parts to make them functional for a particular vehicle. For example, one master mechanic was observed shortening the shaft of an oil pump that had just been purchased so that it would fit in the old pump housing. There is also the clever cannibalizing of components from other vehicles. One Koforidua master has become something of a local legend for his ability to take components from one vehicle and adapt them to another. The author has seen him do this on several occasions with gearboxes and clutches. He cuts a new hole here, files off an edge there, and generally modifies both the component and the vehicle until they match each other. The improvisations he and others make are sometimes not aesthetically pleasing, but they do indeed work. And they save the happy owners substantial sums of money.

Another class of improvised repairs is the homemade part. For example, if a gear in the gearbox has a chipped tooth, some wayside mechanics simply weld a small lump of metal on that spot and then file it until it matches the other teeth. Another common technique is to have a metal bushing made at the local machine shop to use as a replacement for a worn-out bearing. Mechanics often cut out their own gaskets from thin cardboard--a time-consuming job that is made possible by the availability of cheap labor in the workshop. They also collaborate at times with blacksmiths, who can make replacements for such parts as leaf springs. As an example of just how resourceful wayside mechanics can be, a friend of the author, whose car had broken down on the road because of a distributor failure, was put on his way again with the help of a nearby wayside mechanic. The mechanic apparently managed to correct the problem by constructing a makeshift rotor for the distributor out of scrap materials in his workshop.

An array of improvised techniques are used for measurement or adjustment purposes. Wayside mechanics generally are not equipped with micrometers, calipers, tape measures, or other accurate measuring instruments. Consequently, when the need for a precise measurement arises, they often use a strand from a broom as a means of establishing the distance between two points. A Western mechanic knows that for true exactness in tightening the bolts of the cylinder head of an engine, a torque wrench must be used. Wayside mechanics simulate this by judging the "feel" of the tightness --an aptitude that apparently comes from long experience at this task. Electrical adjustments such as setting the distributor timing or adjusting the charging voltage also require electronic instruments for true accuracy. Here, too, wayside mechanics attempt to make critical adjustments "by the seat of their pants," so to speak. When these adjustments are done by someone with discriminating judgment, their estimates may be within an acceptable range of operation. Without such judgement more often than not they are sheer guesswork.

Of course, not all wayside mechanics are equally skilled at making improvised repairs. Perhaps only a small minority of them are genuinely inventive most of the time. Moreover, as one might suspect, not all improvised repairs and techniques are sound practices even though they may be quite imaginative. Many of these repairs simply do not last, and some are downright unsafe. One example of an unsafe practice is a procedure commonly used in repairing the wheel cylinders in the brakes. When the brake line begins to leak from the wheel cylinders, mechanics try to correct the problem by wedging small rags around the leaking seals. This stops the leakage and gives the illusion of preserving braking power. However, under a severe braking load the rags can suddenly give way and lead to total brake failure with possibly tragic results.

Another example of a workable but basically unsound practice is a technique used in the overhauling of engines. To get the correct clearance between the connecting rod bearing and the crankshaft, wayside mechanics often sand the bearing cap and bearing surfaces or add shims between the bearing caps, depending on whether the clearance must be decreased or increased. The effect in both cases is to change the basic shape of the fit of the bearing on the crankshaft from circular to elliptical. This condition results in uneven wear on the bearings and eventually leads to the need for a re-overhaul; a very common occurrence in the wayside workshop. It is interesting to note, though, that this same technique may have been common among mechanics in the United States in the 1930's, when engine clearances were not as crucial as they are in the engines of the 1970's.[16]

The means by which these improvisational skills are learned by apprentices is not entirely clear, although it can be assumed that the process is similar to the way other mechanical skills and knowledge are acquired. However, the teaching of improvisational techniques is probably more likely to be the prerogative of the master himself: first, because of the economic considerations that are often the original motive for devising the techniques; second, because many of the techniques tend to be practiced mainly by workers at the most advanced stages of training; and third, because the techniques usually emerge only after years of wrestling with the chronic problems of the trade. The master, as both the custodian and the beneficiary of workshop profits, is more fully conscious than his workers of the importance of finding an easier or cheaper --or, in some circumstances, even any--way to make a repair.

Because their improvisations are so genuinely spontaneous, quite possibly they are not so much hard skills (although some indeed are) to be passed on to apprentices as much as they are the outward signs of a fundamentally different approach to the work. More than anything else, they represent a willingness to tinker with a mechanical apparatus, to perhaps disregard an accepted axiom of mechanics, or to make a repair in an unusual or different way. In a non-technical developing society like Ghana, such an approach is given constant reinforcement by the conditions under which wayside mechanics operate. In the absence of a different mode of training or different economic circumstances, it is not unusual that the improvisational capacities of Ghanaian wayside mechanics would be very highly refined.

FOOTNOTES--CHAPTER IV

[1] Field notes, July 21,1977.

[2] W. Douglas Seymour, Industrial Skills (London: Sir Isaac Pitman and Sons Ltd., 1966), pp. 85-86.

[3] Ibid., pp. 268-269.

[4] Glenn L. Bryan, "The Training of Electronic Maintenance Technicians," in Training Research and Education, ed. by Robert Glazer (New York: John Wiley and Sons, Inc., 1962), pp. 305-309.

[5] Seymour, op. cit., p. 269.

[6] Michael Polyani and Harry Prosch, Meaning (Chicago: The University of Chicago Press, 1975), p. 50.

[7] Ibid.

[8] The seemingly long periods spent on the first two activities (i.e., cleaning the workshop and packing away the tools) does not represent the actual learning time,but instead the amount of time apprentices were obligated to perform those tasks before new apprentices entered the workshop and assumed responsibility for them.

[9] There may be some disagreement among expert mechanics about the relative difficulty of different repairs. Also, the sequence of learning for any apprentice depends on the type of workshop in which he works. For example, apprentices in a truck repair workshop would not learn about distributors until much later due to the fact that diesel trucks are not equipped with distributors.

[10] The points do not open "more"; they open earlier.

[11] The latter two items were excerpts from an interview with Kevin Davis, a C.I.D.A. expert who has been assisting wayside mechanics with some of the technical aspects of their work.

[12] K. W. Tilley, "Fault Diagnosis Training for Maintenance Personnel," in Ergonomics, X, No. 2 (1967), pp. 210-211.

[13] Claude Levi-Strauss, The Savage Mind (London: Weidenfeld and Nicolson, 1966), pp. 16-22.

[14] Ibid., p. 17.

[15] Howard Gardner, The Quest for Mind (New York: Random House, Inc., 1974), p. 140.

[16] Private communication with Howard Wing, an automobile mechanics instructor in a technical secondary school in Palmer, Massachusetts.

CHAPTER V

IMPLICATIONS OF INFORMAL SKILL TRAINING

Up to this point we have taken both a very broad and a very specific look at indigenous skill training in Africa. In Chapter II the historical background of informal skill training and its relationship to other important aspects of a developing economy were examined in rather general terms. Chapter III focused on the setting and organization of one particular informal training system in a Ghanaian community and Chapter IV intensively analyzed the nature of skill acquisition among the artisans of that trade. Chapter V consolidates these findings and attempts to bring them into a larger perspective.

The first part of this chapter is a recapitulation of some of the major features of the skill learning process in wayside mechanics workshops. After that, the cognitive implications of informal training in motor mechanics are analyzed in relation to the findings from studies of skill acquisition in other settings. These insights serve as the basis for a discussion of some possible training models to improve the skills of wayside mechanics in Africa. The future prospects of small entrepreneurs such as wayside mechanics are then assessed in their broad context of the developing economies of Africa. Finally, the study ends with some concluding remarks about the strengths and weaknesses of indigenous skill training and some suggestions for possible follow-up research.

Informal Skill Learning Re-visited

The process by which skills are learned in the wayside workshops of Ghana has been compared and contrasted with school learning on several dimensions. Both systems have participants who perform similar functions of teaching and learning. Both handle large amounts of knowledge and skill that somehow must be transmitted from "teachers" to "learners." Yet, the school and the workshop differ significantly in the way each accomplishes its training function. Unlike the school, the workshop relies heavily on observation and participation in the work as the main mode of learning. Verbal communication, the school's major medium of instruction, plays only a secondary--albeit important--role in workshop learning.

The wayside mechanics workshop is organized hierarchically with rank and status determined both by seniority and ability. Directions and information are passed down a chain of command originating with the master and ending with the most junior apprentice. As in the medieval craft workshops of Europe, much of the training is done, not by the master, but by the journeymen and older apprentices who are given considerable authority over younger apprentices. Journeymen are obligated by workshop custom to teach what they know to less experienced workers; a mechanism often reinforced by the close working relationships that develop between young apprentices and the older workers they befriend.

The mechanics trade is mastered through participation in the work rather than as a result of any formal instruction. Therefore, access to work is a very critical factor in successful skill learning.

Access, in turn, depends on the volume of business in the workshop and the number of apprentices among which that business must be distributed. While a large workshop may have many repair jobs coming through every day, a small workshop may provide just as much or more opportunity to learn the trade if the ratio of workers to jobs is small. An overall balance in the type of repair jobs received by a wayside workshop is also important if mechanics are to be trained thoroughly.

The earliest assignments a new wayside apprentice faces are mostly mundane, repetitive chores performed for older workers. In time, these low-level tasks give way to more responsible involvement in actual repairs. With increasing competence comes the ability to work independently and to begin supervising younger apprentices. Hard work and skill are rewarded with equally or more difficult assignments in the future, while laziness and sloppy work are punished directly and sometimes severely. Repeated carelessness is likely to lower an apprentice's esteem in the eyes of the master and relegate him to less demanding jobs.

Since most "instruction" in the wayside workshop occurs in connection with the work itself, knowledge and skill are taught only insofar as they are necessary to make a repair. Even then, little information is volunteered by masters and senior workers, except in response to specific questions from younger apprentices. Much of the dialogue between workers consists of simple one-line commands and questions, with relatively few extended explanations. While it is adequate to communicate the expected behaviors, such interaction does not facilitate a real conceptual grasp of the processes and principles involved. Consequently, apprentices generally leave the workshop with little more than a shallow understanding of mechanical theory.

The practical skills of mechanics are mastered cumulatively by repeating an operation over and over. Although the daily business arrives quite randomly in the wayside workshop, there appears to be an identifiable pattern to the way skills are learned. Three general stages of skill development were identified, including: 1) simple, repetitive chores and manipulative skills; 2) repairs of complete components or systems; and 3) diagnosis of faults. The first stage is relatively short; the second is quite long. Within the second stage there is a progression from easier repairs such as replacement of spark plugs or brake linings to more difficult jobs like clutch and transmission overhauls. The ability to work on the engine itself comes only after long experience as an apprentice. Fault diagnosis, the most demanding skill of all, is learned last and, to any degree of proficiency, only after an apprentice has been working as a journeyman or even as a master in his own workshop.

The Cognitive Implications of Informal Skill Training

One of the issues raised at the outset of this study was the question of what cognitive consequences accrue from informal skill training. Is the wayside workshop in any cognitive sense comparable to the formal school? More specifically, is it possible that indigenous skill training might develop some of the same generalized thinking skills as those commonly attributed to the schooling experience? How that the dynamics of the learning/teaching process have been described in detail, this question can be considered once again.

Chapter I cited a study by Lave of problem-solving ability among indigenous tailors in Liberia.[1] The study is recalled here because of features that are analegous to the case of the wayside mechanics. Lave had hypothesized that the inductive, task-oriented mode of learning in a tailoring apprenticeship would lead, contrary to previous belief, to the development of general cognitive skills. As Lave described it:

> The more practice the tailors have and the more exposure to variant performances of the same tasks, the more opportunity they will have to sort variant from invariant operations and to develop an understanding of what is crucial and what can vary in a given job; in short, to develop a general set of rules governing their work.[2]

The greater the amount of the tailoring exprience, she surmised, the more this learning could be transferred to a greater variety of situations.

The results of Lave's study provide some of the most systematic evidence to date that informal skill training in fact can produce learning transfer of the same sort (although possibly not of the same magnitude) heretofore expected only from formally schooled subjects. A series of problems of varying degrees of familiarity were presented to a group of tailors who differed both in the amount of their formal education and in their tailoring experience. Among other results from her preliminary analysis, Lave found that tailoring experience as well as formal education accounted for differences in their performances on both familiar and unfamiliar problems.[3] Apparently, as the result of solving familiar, everyday problems, tailors had acquired the ability to solve problems that were equally difficult but "rarely encountered" in the course of their work. As Lave had expected, the more unfamiliar the problems became, the less likely the tailors were to solve them--i.e., the less learning transfer that took place.

The limited evidence from the present study suggests a similar pattern among wayside mechanics. Like tailors, wayside mechchanics appear to acquire a set of rules, or "functional capacities," as they were called in Chapter IV, as the result of performing the same operations in many different situations. In tracing faults, for example, they learn to associate certain faults with particular symptoms and to apply these associations to all future malfunctions which exhibit those symptoms. A mechanic who has experienced repeated instances of worn-out brake linings accompanied by loud squealing of the brakes and a low brake pedal will soon treat all instances of these same symptoms as probable indications of worn-out linings, even though the exact nature and intensity of the symptoms may not be identical in each case.

One might question at this point whether the routine use of symptom-fault associations to identify mechanical malfunctions in the manner described above really constitutes an example of genuine problem-solving. Indeed, a simplistic and perfunctory reliance on this diagnostic strategy is sometimes referred to derisively as a "cookbook approach" to troubleshooting. Gagné, who distinguishes between rule learning and problem-solving in his hierarchical classification of learning, might well label such routine fault diagnosis as "rule-governed behavior," while reserving the term "problem-solving" for truly novel problems that result in the learning of "higher-order" rules.[4] Similarly, Bryant and his colleagues maintain that fault diagnosis is not problem-solving when "the path to the goal is quite clear-cut and routinized."[5] But, as they go on to point out, insofar as a diagnostic attempt "contains exploration of the situation to determine the crucial elements, alternative approaches, and the relationships between them, then it involves the type of behavior usually called problem-solving." In light of these distinctions, it is safe to say that many--but by no means all--of the diagnostic problems of wayside mechanics can be solved by nothing more than a straightforward application of rules they already know.

The extent to which these informally acquired rules can be transferred from familiar to unfamiliar circumstances within the domain of mechanics is debatable. On the one hand, with increasing experience wayside mechanics appear to gain a greater capacity for what Gagné calls "lateral transfer"--that is, the generalizing of rules to encompass an ever-widening range of situations at approximately the same level of complexity.[6] In this sense, their capabilities may not differ significantly from many Western mechanics, who probably expand their skills through a similar mode of transfer.

Yet, on the other hand, wayside mechanics, like Lave's tailors, appear to have increasing difficulty in solving problems that are sharply divergent from familiar practice. Just as a tailor's ability to estimate waistbands (one of Lave's familiar tasks) did not necessarily transfer to the problem of estimating the length of a piece of wood (one of her unfamiliar tasks), neither does the wayside mechanic's ability to recognize an ignition malfunction caused by a fouled spark plug (a familiar occurence) necessarily transfer to a far more obscure and infrequent fault such as a deficient spark advance mechanism or an intermittently malfunctioning electrical component, all three of which can produce similar symptoms.

The inability to solve divergent problems within a general range of practice may indicate a low level of "vertical transfer" of learning. Vertical transfer, in Gagne's terms, is the rapid acquisition of "advanced" capability that is made possible by the previous learning of extensive and subordinate capabilities.[7] Such transferability goes beyond the mere expansion of a known rule to cover a somewhat broader class of situations, but involves instead the formulation of a new higher-order rule that can be generalized over an even greater variety of situations. Vertical transfer--as opposed to lateral transfer--of learning in a rigorously technical field like automotive repair would seem to require both considerable practical experience and an understanding of the fundamental processes at work. Thus, to the extent that a mechanic is not limited to his informally acquired experience but possesses, in addition, a rich store of subordinate knowledge and skills obtained through systematic instruction or independent reading, he has the capacity to solve even the most obscure and intractable repair problems. That wayside mechanics probably do not engage in much transfer of this sort shows up in three ways in this study:

1) in the relatively meager amount of knowledge about fundamental mechanical principles and potential malfunctions that they can readily verbalize

2) in the random search techniques they frequently resort to in tracing unfamiliar faults

3) in their relatively sparse use of testing procedures in fault diagnosis, suggesting little in the way of alternative hypothesis generation.

As a footnote to this, it is fair to say that much of the above analysis may apply equally well to at least some portion of Western mechanics. A recent survey of automobile repair shops in seven cities of the United States conducted by the Department of Transportation found that more than half of every dollar spent by consumers in these shops was wasted on needless repairs.[8] Vehicles with very specific minor faults or no faults at all were taken to the shops for repair. Apparently, in 44 percent of the cases the repair was not made correctly, with either the malfunction not being corrected or else additional work being done at added expense to the customer. Interestingly, the survey found little evidence of outright fraud, "as distinct from negligence or incompetence." Such revelations should serve as a reminder for caution when comparing the skills of Western craftsmen with their counterparts in non-technological societies.

Would Theory Help? One might conclude from the foregoing discussion that a strong case could be made for introducing instruction in mechanical theory to wayside mechanics. Such a conclusion would not be unjustified. Repeated instances can be seen where lack of basic knowledge about engine design, chemical reactions, friction, metallurgy, electricity, and fluid dynamics, to name a few, adversely affect the quality of their work. The following example will illustrate the problem.

As pointed out in Chapter IV, a common practice among wayside mechanics is to cannabilize working components from one vehicle to replace inoperative units in other vehicles. Most of the time this is a perfectly acceptable way to recycle parts which might otherwise be discarded. However, trouble sometimes arises because the canabilized component is not an exact duplicate of the one it replaces. For instance, wayside mechanics have been observed adapting master brake cylinders with larger size pistons for use in other vehicles.[9] A rudimentary understanding of Pascal's law of fluid pressure would be sufficient to figure out that a master cylinder piston with a larger area would produce less braking pressure to the wheel cylinders, resulting in reduced brake performance for the same amount of foot pressure on the brake pedal.[10] If wayside mechanics were more aware of the theoretical principles involved in brake systems, they probably would not make such potentially dangerous improvisations.

Yet, as valuable as basic physics and chemistry really are in moulding well-rounded mechanics, it is possible that only a certain kind of "theoretical" knowledge is actually indispensable in their work most of the time. In a study of aircraft electro-mechanical maintenance personnel in Britain, Tilley found that there was not as much correlation between fault diagnostic ability and theoretical training--that is, in the sense of knowing basic mechanical principles--

as one might think.[11] Much of this knowledge apparently was forgotten soon after the technicians left training and were placed on the job. Instead, the knowledge that was most crucial to their overall effectiveness on the job was their grasp of what Tilley calls "the functional inter-relationships" in the equipment. Implicit in this is a systems approach to mechanics instruction.

A systems approach to mechanics would seem to have direct implications for fault diagnosis. Knowing the functional interrelationships between the component systems of a motor vehicle provides a more general method for tracing unfamiliar faults and thus eliminates the need to resort to random search. For example, as we pointed out in Chapter IV, a mechanic who knows the seven basic systems of the carburetor probably will be able to repair a malfunction in any carburetor, regardless of whether or not he has worked on the model before.

The reason why a systems approach may be advantageous for fault diagnosis is that it tends to focus attention on the *strategies* of solution. Gagne, for one, notes the importance of strategies within the context of problem-solving. He defines strategies as higher-order rules that are independent of the problem solution itself, but which facilitate the process of finding a solution.[12] They are, in his view, highly personal, adaptive behaviors which shape the way an individual solves the problems he meets, regardless of their content. Although normally self-learned during the act of solving a problem, strategies appear capable of being deliberately taught to others. For example, in Tilly's study, maintenance personnel who had learned about the functional inter-relationships of the components, were instructed on how to search (in other words, equipped with a strategy) for a fault in a particular type of structured system. Personnel who had been given a systems approach to the equipment along with strategies for tracing faults in those systems developed diagnostic abilities that generalized over a wider range of equipment than individuals with conventional training in fundamental theory.

Improving the Skills of Wayside Mechanics

As the last section has shown, informally trained mechanics do have some serious deficiencies in their training that can impair their performance both as mechanics and as successful small businessmen. Fortunately, many of these weaknesses can be addressed through appropriate intervention either during the initial training itself or later at the level of practice.

Although improvement programs with working artisans have been little tried as of yet, there is some limited evidence that trade training of a more organized or systematic nature may have some beneficial effects. In a study of the work output of Ghanaian artisans in relation to their educational/training background, Aryee concluded, among other things, that those artisans who had received specific trade training in an institution were more productive (i.e., had a higher output) and had higher earnings than artisans with only the usual apprenticeship training.[13] As a policy prescription, Aryee suggests that the productivity of many informal operators (not just wayside mechanics but many different tradesmen) could be enhanced through wider coverage of short technical courses now available to only a relatively few.

There are several ways to go about raising the standards of workmanship in the wayside mechanics profession, and some of these approaches are already being successfully implemented in different parts of the developing world. For example, one might start with the assumption that all attention should be focused on the apprentices coming through the system. After all, apprentices are the master artisans of the future and it makes sense, according to this line of reasoning, to insure that the next generation is as competent as society can make them. On the other hand, one could argue that it is wiser instead to direct all efforts to improving masters alone. Apprentices are certainly important, but it is the existing masters who control the bulk of the repair services in the society and who will continue to train apprentices for many years to come. Somewhere in between these two opposite approaches is a middle position which maintains the wisdom of training some combination of apprentices and masters.

Still another position centers around a belief in the eventual demise of the small workshop or their consolidation into larger business units. From this perspective, the profession would best be improved by attracting into it young people with more formal education to serve as the future managers or entrepreneurs of these larger-scale enterprises. The thrust of any enrichment program, therefore, would be directed as much toward making capital available to purchase new equipment and upgrade facilities as for improving skills themselves.

There are also different means of organizing and delivering improvement programs for wayside mechanics. One method is to provide technical advice directly to the artisans on their own premises. Another is to organize a supplementary skill training program for interested wayside artisans who would attend classes after their working hours. Such programs could be undertaken either by established technical institutes or by ad hoc bodies of cooperating institutions. In the rest of this section, three specific programs for improving the skills of mechanics are discussed.

Mechanics Extension Service. One of the more recent and imaginative ways of improving the competency of wayside mechanics is to take expert technical know-how directly to them in the same manner that the agricultural extension officer assists farmers. In this case, an experienced instructor/mechanic visits wayside mechanics' workshops and offers whatever assistance is deemed useful or is requested by the artisans themselves. The advantage of delivering the service to the target audience on their own turf is that it avoids the problem of persuading reluctant individuals to come to a central classroom. Secondly, because new knowledge and skills are introduced in relation to specific repairs in each workshop, artisans have a strong, built-in motivation to learn such relevant material.

A precedent for this approach already exists in Ghana with a CIDA-sponsored project in Accra and Kumasi begun in 1973.[14] The project was conceived and organized by a former CUSO (Canadian University Services Overseas) volunteer mechanic named Kevin Davis.

Before starting the project, Davis had had extensive experience in Ghana both as an auto mechanics instructor and in working informally with wayside mechanics. He was familiar with the problems of wayside mechanics and knew that any efforts to help them would require a very different approach than the old formal technical training route.

Davis sought assistance for his idea from other sources. The Canadian Government helped by donating a pick-up truck and tools and equipment for the project. Institutional support was provided by the Technical Education Division of the Ministry of Education and the project was originally sponsored jointly by the Accra Technical Training Center and CUSO. Sponsorship by the Accra Technical Training Center was important in that it offered a base of operations for the project, a well-equipped mechanical workshop for formal classes, the counterpart staff, and housing for the staff.

Davis and his Ghanaian counterparts spend at least four days a week visiting wayside workshops in different parts of the city. They travel in the project's paneled Dodge pickup with the word "understanding" --for which the whole team is now popularly known--aptly painted on the front. The enclosed section of the truck houses a complete mobile workshop while the side panels serve as handy chalkboards for explaining mechanical principles to the artisans. Although a regular visitation schedule is followed, the team tries to remain flexible to accomodate artisans who may have repair problems which require special attention.

In addition to the workshop visits, formal evening classes are held for mechanics who are interested in more intensive instruction.

The team is also available to help individual mechanics, who often come to the Institute with particular problems. Davis spends one day a week training the counterpart staff and maintaining the project's vehicle and equipment. As of 1977 he had fully trained a Ghanaian counterpart who took over the project in Accra, while he went on to replicate the project in Kumasi.

The project seems to have enjoyed considerable success. Although Davis and his co-workers were greeted initially with suspicion by some individuals, they gradually won the confidence and respect of the artisan community. Artisans now eagerly await the team's weekly visits in order to present them with their most obstinate repairs. Davis is particularly qualified for this role since he knows how to help them with the problems they cannot handle. As he notes, most wayside mechanics are competent in dealing with the majority of repairs they encounter and, indeed, may resent any attempt to assist them in a condescending way. But, in helping them with the real "toughies," Davis creates opportunities to explain relevant mechanical theory and build credibility for himself.

The program is beneficial in another sense. It has made it possible for Davis to introduce some simple but highly useful test equipment which could raise the quality of certain repairs. One such item is a standard voltmeter, costing about $45, that he has supplied to some of the auto-electricians and taught them to use. Among other functions, the voltmeter is essential in accurately setting the charging voltage in an auto ignition system. Incorrect charging voltage resulting from the lack of this instrument is the cause of much damage to automobile batteries and other electrical components in Ghana.

Davis himself sums up best the positive results of the project:

> In terms of the fitters themselves, for most of them, this is the first real interest that has been shown to them in the field by an educational system. Most are quite pleased that someone is willing to come to them, see their problems and is willing to help them. It means an increase in their knowledge, knowledge which they can build upon to apply to a wide spectrum of jobs. Many of them have always done one thing because that was all they had been trained to do. It means learning how to best use their tools, how to purchase tools, or to set up their workshops to their own benefit. It means learning safety features and better training for their apprentices. For the young apprentices it is especially helpful since much of the wealth of information is shared with them.

Supplementary Skill Training. A second major approach to improving the skills of wayside mechanics is after-hours supplementary training for interested masters and apprentices. In contrast to the mechanics extension service, this approach is closer to a formal training experience in that trainees attend classes as a group and learn the subject in an orderly sequence.

However, some important considerations must be taken into account in the design of a supplementary skill program. It is tempting for the formal educators who may be involved in these efforts to design a training program that may be beautifully effective for a student in a technical secondary school, but thoroughly inappropriate and useless for a wayside mechanic. Many of the individuals who choose to become wayside mechanics have a history of failure in school, and their decision to take up a practical trade like mechanics is, in a large sense, a response to their lack of success in school. Also, if there is anything this study has contributed, it is the understanding that apprentices in an informal learning setting use a far different mode of learning than do students in school. The learning mode in any supplementary training program must take account of these differences. Therefore, from the viewpoint of the credibility of the program, the motivation of learners, and the effectiveness of the learning, it is essential to avoid any approach that resembles too closely the style and format of the formal school.

Ideally, the curriculum should build upon the existing knowledge and skills of artisans and relate closely to their everyday experiences in the workshop. For example, classes for experienced masters might use the typical repair problems this group faces as points around which key mechanical concepts and principles could be organized. In the case of apprentices, who are less experienced than their masters, a more fundamental approach might be taken, perhaps beginning with the elementary systems question, "What is necessary to build an automobile?" However, because neither masters nor apprentices have amassed any considerable knowledge about mechanics through verbal modes of learning, explanations by instructors will be understood better if they are tied to vivid and concrete exemplars in the real world of the workshop. It would be important to organize topics around practical learning experiences using real motor vehicle components and a variety of tools and equipment to work with.

The program might take up non-mechanical subjects as well. Workshop safety procedures is a vitally important topic that receives all too little attention in most wayside apprenticeships. Instruction in small business management would be of immense practical benefit to many artisans. By being shown how to keep a simple accounting book, how to anticipate their needs for certain spare parts, the advantages of buying in bulk, and how to make more efficient use of their labor, artisans could turn their small businesses into more profitable enterprises. Even literacy training could be included in the curriculum. Many mechanics emphasize the importance of being able to read mechanics textbooks and repair manuals and to know the precise names of spare parts when making purchases from parts dealers. Existing literacy methods could be adapted for use in developing a functional literacy suitable for those in the mechanics trade.

The Kumasi Program. A successful model of skill upgrading is a program conducted by the Kumasi Vocational Training Center in Kumasi, Ghana.[16] The program was initially designed to serve only apprentices in local wayside mechanics workshops, although organizers have contemplated extension of the program to include local masters. Apprentices currently are accepted into the program after they have completed about a year of their apprenticeship.

Apprentices participate in the program on a "day release" basis. Two days a week each of two sections comprised of fifteen apprentices comes to the Center while the rest of the week they remain in their masters' workshops. The program is organized into three phases. The first phase lasts about three months. After completing this phase the apprentices go back to their own workshops full-time. After about nine months they return to the program for the second phase which is also three months in length. Altogether the three phases take three to four years to complete, thus making the program coterminous with the indigenous apprenticeship.

Each phase is more intensive than the preceding one. Instructors say that the emphasis is heavily on the practical side (75 percent practical; 25 percent theoretical). A problem approach is used throughout the training. For example, a fault will be created purposely in an engine and trainees are then expected to diagnose the fault. The instruction is geared to the trade testing system run by the National Vocational Training Institute of Ghana. Successful completion of all three phases is considered the training equivalent of a Grade I mechanic according to N.V.T.I. standards.

In addition to the training given to an apprentice in his primary field, some training is also given in allied fields. For instance, a mechanic would learn aspects of auto-electircal repair, welding, and machine shop operation in phases two and three. The rationale behind this is that if the apprentice later becomes employed in a big firm, he could be promoted more easily to foreman since he is familiar with all the operations of a large mechanical workshop. If he decides to open his own workshop, he will be competent to train his apprentices in several affiliated skill areas and thus turn out more comprehensive craftsmen.

The program profits enormously from its sponsorship by the Kumasi Vocational Training Center with its large workshops, classrooms, and permanent staff. The workshops are well-equipped with hand and power tools, cutaway engines, and component parts. There is a large amount of instructional materials available to the program, including books, wall charts, audio-visual aids, and duplicated hand-outs for trainees. The Center has received, at least in the past, considerable material and financial support for its programs from various international organizations, including the International Labor Organization and the British Council. This aid has been an important factor in allowing the Center to move forward with innovative programs such as the one with wayside apprentices.

The Koforidua Program. A similar skill upgrading program has been started recently in Koforidua.[17] Although set up under rather different sponsorship, the Koforidua program has the same goal of delivering specially tailored supplemental training to an occupational group previously ignored by the educational establishment. The program sprang from the author's interest in putting into practice some of the findings of his research and from his desire to leave something of value behind for those who had facilitated that research. The possibility that a research study and an educational treatment could cross-fertilize one another in a way mutually beneficial to both the researcher and the researched was a major incentive to begin preparations for the program.

At the beginning, the project had virtually no resources with which to work. There was no place to hold the classes. There was no funding to finance the program. There were no tools, equipment, and instructional materials of any sort. Nor were there any instructors to teach the classes. There was only the belief among the organizers and some of the artisans that the idea of supplementary training was worth pursuing.

If nothing else, the program stands as an eloquent testimony to the almost limitless possibilities of multi-lateral cooperation. The first breakthrough in support came with a major donation of tools and equipment for the program from the German Adult Education Association. The willingness of one agency to provide financial support seemed to have a snowballing effect on other organizations. The Institute of Adult Education at the University of Ghana, Legon soon became the sponsoring institution and agreed to provide the operating budget for the program. The Eastern Regional Government, in which Koforidua is located, put up money for the furniture for the workshop and one of the large multi-national companies operating in Ghana, which had an unused facility in Koforidua, furnished a large room for the classroom/workshop at nominal rent. Since the Institute had little previous experience in administering technical education programs, the Opportunities Industrialization Centers, Ghana, a transplanted American concept which has been successful in training unemployed youths, offered some of its staff as consultants and helped to select and train the instructors for the program. Finally, in order that the artisans would feel that they contributed to the program, members of the Koforidua Artisans' Cooperative society were consulted about the design of the program and participants were asked to pay a small nominal sum for the right to attend classes.

Because the instructors are professional mechanics who are employed full-time in Government workshops, the classes are held in the evenings after the normal hours of the work day. Separate classes of fifteen trainees each have been organized for apprentices and masters. Each section meets twice a week for two or more hours for the duration of the couse. It is anticipated that the course may take a year and a half to two years to complete depending on the starting level of the class and their rate of progress. The organizers also felt that it would be important to have classes for both masters and apprentices to avoid situations where apprentices learn skills or knowledge that their masters do not possess. Any unintended disruption of the delicate status differences between masters and apprentices could prejudice masters against the program and, in effect, scuttle it.

It is too early to evaluate the success of the program. However, two comments can be made. The program's major sponsor, rather than one of the established technical institutes, was an institution known primarily for its liberal studies courses for teachers, suggesting that even organizations with a long tradition of certain activities can be persuaded to adjust their priorities and undertake experimental programs in very different areas. Secondly, the program demonstrates vividly what is possible with only minimal initial resources.

The Future of the Small Craft Workshop

The study would not be complete without some speculation on the future prospects of the small workshop and its apprenticeship training in the African developing economy. There is by no means unanimity among observers of the informal sector on whether there will be a future role for the small enterprise and, if so, what kind of role that will be.

On the one hand, there are those who believe that the small craft workshop, regardless of its present ubiquity in African towns and cities, is ultimately doomed to a dead-end line of development. They see the small size of the concern and the lack of literacy, general education, and entrepreneurial skills among its master artisans as inhibitions to any real development. Artisans lack the capital to transform their businesses into bigger operations and there seems little likelihood that their access to large amounts of credit will soon improve. The tenuous location of many of their owrkshops on rented land, which can be withdrawn from their use at any time, makes it risky to invest in heavy capital goods or permanent improvements to the site. Although some small operators in some trades will survive, many others will be swept aside by ambitious entrepreneurs with more education and business savvy who can grasp the implications of a widermarket and drive out smaller and less-capitalized competitors.

On the other hand, there are those who believe the small workshop to be a transitional institution from which larger, more efficient economic units might evolve. These experts view the small workshop as an integral part of a developing economy because of its capacity to produce for the low-income population the same services and products as those available from the formal sector. Admittedly, as

Callaway declared, informal artisans are "imitators" rather than innovators in that they have added few basic changes in design or made few improvements in the production process, save making products more cheaply.[18] However, spreading even cheap imitations of existing products (and services) to large segments of the population still not covered is seen as more important at this point than the creation of genuinely new products.

Yet, small-scale entrepreneurial activity may not necessarily be conducive to industrial development unless certain pre-conditions have been met. According to Udy, entrepreneurship will facilitate industrial development only when labor specializaton is well-established and a sufficient technological orientation has been achieved.[19] As Udy puts it,

> Unless a firm basis for industrial development exists in the occupational system, entrepreneurial activity is likely at best to be irrelevant to industrialization. . . . The result is a nation of shopkeepers and clerks, rather than a corps of technicians.

As Chapter II pointed out (see page 28), such labor specialization and technological orientation are the direct result of the continued expansion of job-specific forms of contractual organization into the work unit.

It is questionable whether the small workshop sector in Africa possesses an adequate occupational and technological base to proceed to what King calls, "the next technological level."[20] Throughout Africa, the informal sector appears to lack vertical integration with higher levels of technology and, in particular, is remote from the complex technology of the large-scale manufacturing and process industries imported from the West. Generally, very little of the mechanization and economy of scale characteristic of the modern sector has been put to use in informal sector enterprises. Artisans have been content to--or simply lack the skills to do anything but--hand-produce more and more of the products previously obtainable only from larger firms.

This is not to say that such vertical integration is not possible. Some movement toward small factory production or engineering industries already is taking place in different parts of Africa. Chapter II cited King's description of the informal machine-makers of Kenya who designed and built their own hand-operated machines for manufacturing certain non-traditional products. Among the artisans of Ghana, Chapter IV cited the example of blacksmiths who could manufacture with known techniques certain kinds of mechanical tools and a few spare parts. Callaway has noted in his writing other examples of product innovation where Nigerian blacksmiths have learned how to forge such modern items as photographers' stands, barber chairs, iron bedsteads, and iron chair frames.[21] The author himself has seen displays of the extraordinary variety of intricate metal implements that can be fashioned by blacksmiths, ranging from door latches to firearms. As Callaway has noted, these new products all represent a potential foundation for a light engineering industry.

But much more movement in the direction of "intermediate" levels of technology could be made. For example, in the field of mechanics many different kinds of spare parts might be made by traditional blacksmiths working in league with mechanics. That this kind of experimentation with new products is possible is being proved already by the Technology Consultancy Center of the University of Science and Technology at Kumasi. The Center has been assisting local artisans and small entrepreneurs in developing new products or improving the efficiency of their operations through mechanization. These efforts include the revival of the lost-wax method to cast modern implements such as door handles, pump components and possibly automobile spares; manufacture of carriage bolts with used machine tools imported from Great Britain; and the construction by local craftsmen of various hand-operated farm machines.[22] With the right machines and raw materials and appropriate supplementary training, officials of the Technology Consultancy Center believe that local artisans could produce such automotive items as air and oil filters, exhaust units, and rubber seals.

Any expectations that craftsmen will make substantial improvements in their technology or adopt new product lines will require changes in their attitudes toward profits. There is a tendency among informal artisans, at least in Ghana, to plough their earnings into transport vehicles, houses, and farms rather than into their businesses. For example, few mechanics have invested in the type of power tools and structural improvements that are found in the large workshops of multi-national companies. Specialized hand tools, power equipment, testers and tune-up devices, and installation of inspection pits would improve the quality and speed of their work. In short, most wayside mechanics and their allied artisans are quite satisfied with the small size and simple hand-tool technology of their firms and have no desire to capitalize so highly that they must pay trained specialists to operate their machines.

What are the implications for the small-scale artisan in moving to the next technological level? In Europe during the nineteenth century, the older craft sector gradually was replaced by the expanding factory system.[23] The skilled artisan became superfluous as his function was divided between the mass of relatively unskilled machine operators, on the one hand, and the few technically sophisticated designers and engineers, on the other, whose skills called for training far beyond the conventional apprenticeship. Consequently, the apprenticeship system became restricted to the building trades and a handful of maintenance professions like mechanics and nonstandardized production crafts catering to an elite clientele.

Will the same thing happen to the African craft sector? Undoubtedly, small, inefficient firms in some vulnerable crafts will be pushed aside or forced to adopt more efficient methods by larger, more vigorous enterprises. Already, movement in this direction is underway on a limited scale in the bigger cities of West Africa, initiated not only by individual entrepreneurs but also by groups of cooperating artisans.[24] But the consolidation of informally trained artisans into larger and permanent economic units is not likely to happen very soon on any massive scale to wayside mechanics or, for that matter, to most indigenous artisans whose mode of production is labor intensive. Mechanics probably will not invest in expensive labor-saving machinery while an excess of available labor exists in the form of apprentices. As long as this seemingly endless supply of cheap labor continues and they can offer their services more cheaply than the large workshops, they would seem to have the power to survive in their present form for some time to come.

Conclusion

The major themes of the study have now been brought into clear focus. The nature of the process by which learners acquire skills and knowledge in an informal learning setting has been described, and the success of that setting in creating opportunities for its learners to acquire those skills has been assessed. As expected, the learning process has been found to be radically divergent from the familiar verbal learning/teaching mode of the school, although both, of course, share certain surface similarities. However, this style of learning which is based on observation and participation in the work was found to be an appropriate and familiar mode for learning the practical tasks of the trade.

As for the success of the system, it can be said with some assurance that the indigenous apprenticeship does an effective and, indeed, admirable job of accomplishing what it claims to do, which is to train young artisans for successful commercial practice in their profession. Apprentices leave their master's workshop in possession of a viable repertoire of practical skills for dealing with the actual repair problems they will face on the job. For the vast majority of apprentices, these skills are soon put to productive use in the society at large, either in the form of skilled employment or self-employment.

Perhaps equally importantly, the indigenous apprenticeship performs some unique functions in preparing young artisans for their role as small businessmen. Although formal vocational schools and technical institutes also teach the technical skills of motor mechanics, only the wayside workshop provides the opportunities to learn some the important entrepreneurial and managerial skills they will need in operating their own workshops. An apprentice who has stayed with his master for four or five years will have acquired considerable experience in supervising younger workers, taking overall responsibility for the quality of repair jobs, dealing with customers, and cultivating relationships with spare parts dealers. Often, these entrepreneurial skills are overlooked by critics of indigenous training and frequently even by the apprentices and master themselves. With all the attention given to the technical skills of the trade, it is sometimes left unrecognized that a whole dimension of valuable managerials skills are being learned quite unconsciously by apprentices.

To be sure, the indigenous apprenticeship does have some weaknesses which are serious enough to warrant corrective action. This study has documented the failure of informal skill training to develop the kind of higher-order conceptual understanding of the subject that is necessary for a sophisticated technological field like motor mechanics. These weaknesses are of special concern in view of the expressed desire by many national leaders and by the artisans themselves to improve the technical proficiency of the vehicle maintenance professions. However, as this study has tried to show, these weaknesses in the mechanics trades are capable of being remedied by appropriate supplementary programs which are organized around the existing training system of the wayside workshop. There is no need, in this author's opinion, to devote one's efforts to bringing fresh blood into the vehicle maintenance industry from among the schooled population when tangible improvements can be made by working with artisans who are already on the job.

In attempting this task, there will be a need for relevant future research. For example, more detailed studies of the problem-solving, diagnostic behavior of both apprentice and master artisans may reveal more clearly exactly how these skills are learned and how they are deployed on the job. This information would be of value to a training program that is attempting to modify or enrich fault diagnostic skills among artisans such as wayside mechanics. It would also be valuable to have a study of the effect of the limited tools with which they work on their cognitive approach to the work. And certainly the influence of factors such as formal education and formal vocational education on apprentice skill acquisition is a topic of interest to educational specialists and cross-cultural psychologists alike. Any supplementary skill training program for self-employed artisans will likewise need to be closely monitored for its effectiveness and impact.

In conclusion, the indigenous apprenticeship has been a familiar learning setting in one form or another for many generations. It has served a useful and important function in African societies by training young people in the essential trades of their communities. Today, despite the introduction of the formal educational system and the radical shift toward large-scale means of production, the small workshop continues to provide essential services and viable training alternatives for many thousands of young people. Its role could be enhanced with the right encouragement and inputs, including appropriate supplementary skills-upgrading, from the government and other outside organizations. But, with or without this assistance, the indigenous apprenticeship will continue to be an important part of the African educational landscape.

FOOTNOTES --CHAPTER V

[1] Jean Lave, "Cognitive Consequences of Traditional Apprenticeship Training in West Africa," in Anthropology and Education Quarterly, Vol. XIII, No. 3 (1977).

[2] Ibid., p. 178.

[3] Ibid., p. 179.

[4] Robert Gagne, The Conditions of Learning (New York: Holt, Rinehart and Winston, Inc., 1970), p. 211.

[5] G. L. Bryan, N. A. Bond Jr., H. R. La Porte Jr., and L. S. Hoffman, Electronic Troubleshooting: A Behavioural Analysis, Electronics Personnel Research Technical Report No. 13 (Los Angeles: Department of Psychology, University of Southern California, 1956), quoted in H. C. Dale, "Fault Finding in Electronic Equipment," in Ergonomics, I, No. 4 (1958), 357.

[6] Gagne, op. cit., pp 333-337.

[7] Ibid., pp. 337-338.

[8] Ernest Holsendolph, "Faulty Car Repairs Found Widespread," New York Times, May 8, 1979, p. 1.

[9] The author is indebted to Kevin Davis for this example.

[10] Martin Stockel, Auto Mechanics Fundamentals (South Holland, Illinois: The Goodheart-Willcox Company, Inc., 1974), p. 338.

[11] K. W. Tilley, "Fault Diagnosis Training for Maintenance Personnel," in Ergonomics, X, No. 2 (1967), 210-211.

[12] Gagne, op. cit., pp. 229-333.

[13] Georges A. Aryee, Effects of Formal Education and Training on the Intensity of Employment in the Informal Sector: A Case Study of Kumasi, Ghana, Education and Employment Research Programme of World Employment Programme (Geneva: ILO, 1976), pp. 33-36.

[14] Private communication with Kevin Davis, 1977.

[15] Keven Davis, Technical Extension Project (Ganah), 1974, p. 2.

[16] Information concerning this program was obtained during a visit to the Center in 1976.

[17] See Stephen McLaughlin, "Support of Indigenous Vocational Trades," in Nonformal Education in Ghana, ed. by David C. Kinsey and John W. Bing (Amherst, Mass.: Center for International Education, 1978), for a full description of the educational activities that were undertaken on behalf of the wayside artisans of Koforidua.

[18] Archibald Callaway, "From Traditional Crafts to Modern Industries," in Odu, II, No. 1 (1965), 29.

[19] Stanley Udy, Jr., Work in Traditional and Modern Society (Englewood Cliffs, N.J.: Prentice Hall, Inc., 1970), p. 93.

[20] Kenneth King, The African Artisan (New York: Teachers College Press, Columbia University, 1977), p. 206.

[21] Callaway, op. cit., p. 33.

[22] J. W. Powell (Ed.), Annual Review, No. 5, 1976-77 (Kumasi, Ghana: Technology Consultancy Centre, 1977).

[23] Paul H. Douglas, "Apprenticeship," Encyclopedia of the Social Sciences, I (New York: MacMillan, 1930), p. 145.

[24] See Michael Koll, Crafts and Cooperation in Western Nigeria (Bielefeld, Germany: Bertelsmann-Universitatsverl, 1969), for a discussion of how craftsmen cooperate informally in certain entrepreneurial activities such as sharing tools and the same workshop quarters, sharing large orders, buying in bulk, and group marketing of their products.

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APPENDICES

APPENDIX A

INTERVIEW FORM

Interview Form

Wayside Mechanics--Apprentices

A. General Information

1. Name of respondent
2. Date of interview.
3. Respondent's shop
4. Age of respondent
5. Tribal group of respondent
6. Where were you born?
   (town, region)
   What is your home town?
7. What is your marital status:
   Are you. . . single, never married
   . . . married now or
   . . . married before, but not now?

   If married now, how many wives do you have? If married before, how many wives have you had?

8. How many children do you have (of your own)?
9. Do you have any children who are in school now or who were in schools?
10. How long have you lived in Koforidua?
11. Have you lived in any other place besides your home town and Koforidua? If so, where? For how long?
12. How many fitting masters work in this shop? What are their names? Which ones work separately from your master?

B. Training/ Education of the Apprentice

13. Why did you want to become a fitter? How did you first become interested in mechanics work?
14. Who helped decide that you should become a fitter? Were any of these fitters themselves?
15. What do you think you would be doing if you had not become a fitting apprentice?
16. When did you begin your apprenticeship?
17. How old were you when you started your apprenticeship?
18. How long have you been an apprentice?

19. Have you served any other master before your present master? If so, who? Between what years?

20. When do you intend to pay your completion fee and complete your apprenticeship? How long do you plan to stay and work for your master?

21. Have you left your apprenticeship for any period of time while you've been serving your master? If so, for how long? For what reason?

22. Do you now or have you ever worked at any other kind of work besides fitting work? If so, what kind of work? How long have you been doing it (or did it)? (If doing it now) Will you continue to do it after you complete your apprenticeship?

23. Why did you come to Koforidua to learn the fitting work?

24. Do you hold a grade certificate in motor mechanics? If so, what grade? When did you receive it?

25. What languages do you speak? What languages do you read? What languages do you write?

26. Have you ever been to school? If so, what kind of school was it? How many years did you attend and what was the last grade you attended? Between what years?

27. (For a person who was in school before, but not now) Why did you stop school?

28. (For those who have been to school) Do you think school has helped you in any way with your fitting work? If so, how?

29. Did your father go to school? If so, what kind of school was it? What was the last grade he attended?

30. Did your mother go to school? If so, what kind of school was it? What was the last grade she attended?

C. Instructional Methods of Masters

31. There are four ways that an apprentice can learn the skills of fitting work. (Read list) Which one do you think is most helpful to you in learning well? Which one is least helpful to you in learning well? Of the two remaining ones, which one is the more helpful to you in learning well?

    a. The apprentice watching carefully what the master does

b. The master explaining to the apprentice exactly how something should be done

c. The apprentice asking questions of the master until he knows what to do

d. The apprentice trying to do the job himself without any help from the master

32. Does your master ever give you specific instructions on how you should do a certain repair? When does he usually give you these instructions? (If the shop has a Senior(s), ask this question) Does the senior give you specific instructions also? If so, when does he give you these instructions? Who gives you instructions more often--the master or the senior?

33. Does your master ever explain to you why you should do a repair in a certain way or explain something about the fitting work to you (for example, how engines work)? If so, when does he usually do this? Do you have to ask him first before he will tell you, or does he usually explain things without you first asking him. (Use to prompt) Does he usually explain things when:

a. you are working on a specific repair job

b. you make a mistake in doing a repair

c. he has some free time

d. or at some other time (explain)

Do you understand his explanations?
How about the senior--does the senior ever explain things to you? If so, who does it more often--the master or the senior? Who gives better explanations--the master or seniors?

34. Does your master ever ask you questions to find out if you understand the mechanics work? When does he usually ask you these questions? Does the senior ever ask you questions? When does he usually ask them?

35. Do you ever ask your master questions about something you don't understand? How many times do you do this a week? Does your master like it if you ask questions about something you don't understand or does he get annoyed if you ask him questions? Does the senior like it if you ask questions or does he get annoyed?

36. Does your master come around to check up on how well you've done your work? If so, does he check every job? Does he usually come around to check while you are working or after you've completed

your job? Does the senior also check up on how well you're doing your work? Who checks on you more closely--the master or the senior? Do you learn more when you are working by yourself or when the master is watching you closely?

37. Does your master ever tell you how well you are doing your work? Does he praise you if he thinks you are doing a good job? Does he give you any kind of reward if you do good work? If so, what? Does the senior also tell you how well you are doing?

38. From whom do you learn more about the mechanics work--from the master or from the senior? Please explain.

39. How good do you think your master is as a teacher? (Pause) Do you think he's a very good teacher, a little bit good as a teacher or not a very good teacher at all? Does he seem to care much about how well the apprentices are learning? Do you think he should spend more time teaching apprentices?

40. Who do you think is more responsible for how well an apprentice learns the fitting work--the master or the apprentice himself? Please explain.

D. Task Assignment and Access to Learning Opportunities

41. These next questions have to do with how the work in the shop gets done and who does it. First of all, how are apprentices usually assigned to work on the jobs in the shop? (Pause) Who usually tells you which job to work on--the master or the senior? If no one tells you what job to work on, how do you know what to do? How many men usually work on a job?

42. If the only job in the shop is one which you don't know how to do, do you go and try to work on it or do you let one of the more experienced apprentices work on it? How do you begin to learn a repair job that you do not know how to do?

43. Do you think that there are enough vehicles coming into the shop for different kinds of repairs for you to learn all the various repair jobs--or is business too slow to see many different repair jobs? Would you like to work more than you do now?

44. Do you think there are too many apprentices in the shop for the amount of business coming in--or are there not enough apprentices in the shop to do the work? Do you think you could learn faster if there were fewer apprentices? Please explain.

45. On the average, how many days a week are you present in the shop? How many hours are you present in the shop everyday? How many of those hours are you usually working? What do you do if the business in the shop is slow?

46. What do you do with your time when you are not in the shop? Do you ever do any repair work on the side when you are not working in the shop?

47. When a vehicle comes into the shop for repairs, does your master ever ask you to talk with the dirver to find out what's wrong? If so, how many times a week does he do this?

48. Does your master ever send you to take care of a disabled vehicle on the road? How many times a week does he do this?

49. Does your master ever send you to buy spare parts? Does he send you to Accra or Kumasi for parts? If so, how often does he do this?

50. Are there some jobs that your master assigns you to do more often than others? If so, what are those jobs?

E. Organization of the Content of the Apprenticeship Training

51. I'm very interested in what you have learned since you've been an apprentice. I want you to think back to the time when you first began your apprenticeship and tell me exactly what you learned when you first entered the workshop? What things did you learn in your first six months as an apprentice? (Ask for each skill) How long did it take before you could do that skill by yourself without any help? During the time you were learning that skill, were you learning anything else? If so, what other things were you learning? (Repeat this sequence of questions for every six month period for as long as the apprentice has been in training) (Record answers on separate grid form.)

52. What is the most difficult repair job that you've learned so far? What is the easiest thing you've learned as an apprentice so far?

53. I am going to read a list of repair jobs that are often done in fitting shops. If you have actually worked on that job, I want you to tell me whether you think that job is very difficult to learn, a little bit difficult to learn, or easy to learn. (Record answers on separate form.)

F. Skills and Knowledge of Workshop Personnel

54. In the next few questions, I want you to tell me about the mechanics ability of your master and the senior. How good do you think your master is as a mechanic? (use to prompt if necessary) Would you say he's an excellent mechanic, a fairly good mechanic, or not a very good mechanic? Please explain. What about the senior? Would you say he's an excellent mechanic, a fairly good mechanic or not a very good mechanic? Who do you think is a better mechanic--the master or the senior?

55. Does your master know any special tricks that he uses to make a repair when he can't get the spare parts (give an example)? If so, what are some of those tricks? Does he teach the apprentices these tricks?

56. Have you ever seen your master have great difficulty with any repair job? If so, what was the repair? Are there any repairs that he doesn't do very well or that he gives to someone else to do?

G. Motivation and Interest of the Apprentices

57. How is Mr. ______________ as a master? Is he a good master to work for or not such a good master to work for? Why or why not? Does he do anything which annoys the apprentices? If so, what? How about the senior--is he a good person to work for? Why or why not? Does he do anything which annoys apprentices?

58. Do you enjoy being an apprentice? Is the apprenticeship different from what you thought it would be when you first joined the workshop? If so, how is it different? What things are bad about being an apprentice? What things are good about being an apprentice? Would you rather learn the mechanics work in a technical institute or in a wayside workshop?

59. Do you like the mechanics work itself? Why or why not?

H. Obligations and Responsibilities of the Apprenticeship Agreement

60. Why did you choose this workshop in which to become an apprentice?

61. When you became an apprentice in this shop, what did you have to give to your master? Who paid for these?

62. What does your master provide for you? How much chop money does he give you? Is it enough for you to live on? If not, how do you supplement it? Does he provide you a place to stay? If not, who do you stay with?

63. What duties does your master expect you to do regularly for him? Does he ever ask you to do any special tasks or favors for him? If so, what? Does he pay you for doing them?

64. When you complete your apprenticeship, what will you have to give to your master? Who will pay for these?

I. Post-Apprenticeship Employment Plans

65. What do you plan to do when you finally leave this shop? Where do you plan to go to do it? If you can't find a job in mechanics or set up your own shop, what will you do instead?

66. What problems do you think you will face in doing what you want to do? (If respondent says he will look for a job, ask this question) How will you go about looking for a job? (If respondent says he will set up his own shop, ask this question) How will you get the money to buy tools?

67. Do you think your master will help you in any way when you finally leave the shop? If so, how do you think he will help you?

68. Can you give us the names of any boys that you know who have finished their apprenticeships and are either working now or looking for a job? If so, how can we contact them?

APPENDIX B

WAYSIDE MECHANICS WORKSHOPS IN KOFORIDUA

WAYSIDE MECHANICS WORKSHOPS IN KOFORIDUA

Artisans Present

Shop Number	Mechanic	Auto Electrician	Welder	Body Rebuilder	Spray Painter	Blacksmith	Other
1.	3	1	1*				Motorcycle Mechanic
2.	2						
3.	1	2	2				Motorcycle Mechanic
4.	2	1		1	1		Upholsterer
5.			1*				
6.	2						
7.	1	1					
8.	1		1			1	
9.	1	1	1				
10.	1						
11.	1						
12.	1		1			1	
13.	1	2	2				
14.		2					

Shop Number	Mechanic	Auto Electrician	Welder	Body Rebuilder	Spray Painter	Blacksmith	Other
15.	4	1	1		1		
16.	1						
17.	2	1	1			1	Upholsterer
18.	1			1			
19.	1						
20.	2		2*		2		
21.	1	1	1				Carpenter
22.		1					
23.		1	4*		1		Sign Painter
24.	1						
25.		2					
26.	2	1				1	
27.	2	1					
28.	3	1	2*				Carpenter
29.	1	1					
30.	1						
31.	3	1	1				

Shop Number	Mechanic	Electrician	Welder	Rebuilder	Painter	Blacksmith	Other
32.	4		1*				
33.	2		1*		1		Upholsterer Motorcycle Mechanic
34.	1						
35.	1	1					
36.		1					
37.	2		1				
38.	3						
39.	2						

*Does both welding and body rebuilding

APPENDIX C

SAMPLE APPRENTICESHIP AGREEMENT

TUITION AGREEMENT

MEMORANDUM OF AGREEMENT made and entered into this 26th day of October, in the year of our Lord one thousand nine hundred and seventy-five (1975) between ADUMOKA GEORGE of Post Office Box 5, Koforidua in the New Juaben traditional area of the Eastern Region of Ghana, hereinafter known as and called the MASTER FITTER in the first place.

AND

ALUKPOR NYAVO of Manyakponguno Manya Krobo traditional area of the Eastern Region of Ghana, hereinafter known as and called the GUARANTOR/SURETY in the second place,

AND

ROBERT NYAVO also of Manyakponguno in the same District and Region of Ghana, hereinafter known as and called the APPRENTICE FITTER in the third place.

AND WHEREAS IT IS MUTUALLY AGREED BETWEEN THE PARTIES HEREIN AS FOLLOWS: -

1. That the Guarantor herein Alukpor Nyavo will give out his son and the Master Fitter herein will receive and accept the boy into his business and to undergo the training and tuition as from time to time to become a full Master Mechanical Fitter for the period of three (3) years from the immediate date of this document.

2. That for such art and skill to be acquired by the apprentice herein, both the guarantor and the apprentice had agreed to pay the Tuition fee at the expiration of the period of 3 years cash the sum of ¢ 120.00 One hundred and twenty Cedis. The apprentice shall be on his own or what we call Day Student and shall come from his own house to business. On affiliation he will provide in addition to the cash of ¢ 120.00 one live sheep and a bottle of Schnapps.

3. That during the period of Robert Nyavo's apprenticeship, he shall obey all lawful order or orders of the Master Fitter his servants or Agents, and shall on no account absent himself from business without the permission of the Master Fitter.

4. That the apprentice shall not divulge any business secret or secrets to any person or persons unless so asked to do so.

5. That Apprentice shall be responsible for all crimes committed by him such as STEALING or SEDUCING another man's wife.

6. That in the event of the apprentice refusing to stay and run away from the Master Fitter before the expiration of the period of 3 years as agreed upon, the Master Fitter reserves all the right to claim the said sum of ¢ 120.00 from the Apprentice and his Guarantor Alukpor Nyavo to liquidate damages.

7. That the apprentice here had agreed to be bound by the terms of this agreement. And that should the Master Fitter also fail to teach the boy the said art and skill of Mechanical Fitting within the period, NOTHING shall be paid by the Guarantor and the Apprentice to the Master Fitter as tuition fee.

IN WITNESS WHEREOF THE CONTENTS OF THIS HAD BEEN READ OVER AND INTERPRETED TO THEM IN THE KROBO LANGUAGE BY ME WHEN THEY ALL SEEMED TO UNDERSTAND ITS MEANING AND EFFECTS BEFORE TOUCHING THE PEN AND MAKING THEIR MARKS AND SIGS. THERETO.

Afet
....
MASTER FITTER

Alukpor
....
GUARA
(ALUKPOR

....
APPRE

WITNESSES:-

....

....

P.V. NYUMUTEI
LICENSED
WRITER & DEBT COLLE
LICENCE No
FEE PAID
DATE

APPENDIX D

WAYSIDE MECHANICS WORKSHOP OBSERVATION SYSTEM

WAYSIDE MECHANICS WORKSHOP OBSERVATION SYSTEM

Description of Categories

Code #	Behavior Category	Explanations
1	Commands or Directions	Commands given by Master to an Apprentice; or by an Apprentice to another Apprentice.
2	Explanations	Explanations and other work-related talk by Master to an Apprentice; Apprentice to Master; or Apprentice to another Apprentice.
3	Questions	Questions asked by Master of Apprentice; Apprentice of Master; or Apprentice of another Apprentice.
4	Criticism or Reprimands	Criticism by Master of Apprentice; or by Apprentice of another Apprentice.
5	Praise or Recognition	Praise given by Master to Apprentice or by Apprentice to another Apprentice.
6	Listening and Watching	Attentive listening to any work-related talk by Master to Apprentice; Apprentice to Master; Apprentice to Another Apprentice; or Customer to Master or Apprentice. Attentive watching of another worker(s) working.
7	Talk to Customer	Work-related talk by Master or Apprentice to a Customer (Owner or Driver). Includes any kind of verbal statement or question.
8	Active Work	More or less focused work with little or no conservation. Applies to either Master or Apprentice.
9	Movement into or out of and inside the workshop	Moving from job to job; fetching tools; work-related errands. Applies to either Master or Apprentice.
0	Miscellaneous Activity	Not working; or engaged in casual conversation; sitting around; eating, sleeping, etc. Applies to either Master or Apprentice.

Instructions to Observers:

Record an observation with a code number at the beginning of every minute and whenever there is any change in activity.

APPENDIX E

OBSERVATION RECORDS

OBSERVATION RECORD*

Worker Observed D. M. Osei Workshop Friendship Workshop

Status in Workshop: Apprentice ______ Senior ______ Master X

Date of Observation Dec. 16, 1976 Job Replacement of piston rings

Time Observation Begun 11:40 A.M. Time Observation Ended 1:10 P.M.

Elapsed Time 90 Min.

Starting Time	Minute 1	2	3	4	Minute 5	Ending Time
11.40 AM	8	8	8	8	82628	11:45 A.M.
	828	8	8	8	8	11:50
	8	8	8	8	8	11:55
	8	8	8	86	862628	12:00
	86218	8	8	8	89	12:05
	9	90	0	06261	6362	12:10
	6262	626	21	136236	362	12:15
	23606	2	620	06	060	12:20
	1260	01	3636	060	0	12:25
	036	06	60	06161	6	12:30
	09	9	90	0	0	12:35
	0	0	0	0	0	12:40
	0	0	0	0	0	12:45
	0	0	0	0	0	12:50
	0	0	0	0	0	12:55
	0	06	0	0	361	1:00
	161	28	8368	8	862	1:05
	868	628	8628	80236	626	1:10 P.M.

*Sample

OBSERVATION RECORD*

Worker Observed Joseph Mensah Workshop Akan Workshop

Status in Workshop: Apprentice X Senior____ Master____

Date of Observation August 16, 1977 Job Removal of cylinder head

Time Observation Begun 10:10 A.M. Time Observation Ended 10:40 A.M.

Time Elapsed 30 Min.

Starting Time	Minute 1	2	3	4	Minute 5	Ending Time
10:10 A.M.	83603618	86261	8018	808	8	10:15 A.M.
	83618	6168368	6162623	1628	808	10:20
	86808	862163	828	8362636	861623	10:25
	8308	828	8638	8183	62	10:30
	326	83160	13610	0	0128136	10:35
	60	360	036	626362	1807	10:40 A.M.

*Sample

APPENDIX F

FREQUENCY OF REPAIRS AND DISTRIBUTION OF JOBS IN THE AKAN AND MODERN MOTOR WORKSHOPS OVER A ONE MONTH PERIOD

Frequency of Repairs and Distribution of Jobs in the Akan and Modern Motor Workshops Over a One Month Period

Listed across the columns at the top are the various jobs in the wayside workshop. Complete engine overhauling, which includes a number of sub-operations, is listed under a single column as "Engine Overhauling." The number to the left in each cell is the number of times that the repair was done in the workshop on that day. The letter(s) to the right in each cell is the code letter of the worker(s) who participated in the repair. An apprentice is listed as a participant whether he only steadied a part of another worker or assumed the major responsibility for the job. The total number of jobs for each day is listed at the end of each row and the total number of jobs in each job category for the entire period is shown at the bottom of each column.

Code Numbers for Workers

Akan Workshop

Name*	Code Letter
1. Kwame Nortey	A
2. Paul Daku	B
3. Jonathon Addo	C
4. Yaw Baffoe	D
5. Charles Osu	E
6. Joseph Mensah	F
7. Kwabena Dovu	G
8. Kofi Obeng	H
9. Kwesi Asiedu	I
10. Victor Datsumo	J
11. Atta Owusu	K
12. John Afedu	L
13. Robert Kyavo	M
14. Kwaku Frimpong	N
15. Joshua Asare	O
16. Kwadjo Appiah	P
17. George Adumoka (master)	Q

Modern Motor Workshop

Name*	Code Letter
1. Atsu Ayitey	R
2. Daniel Boateng	S
3. Kobina Ezeh	T
4. Martin Danso	U

*In descending order of seniority

Akan Workshop

	Oil Change	Maintenance	Brake Adjustment & Repair	Spark Plugs	Distributor & Contact Set	Carburetor	Radiator	Fuel Pump	Shock Absorbers	Clutch
Nov. 4		2 [illegible]			1 D	1 B				2 [illegible]
5		1 F,L	1 B,K	1 G	1 F	1 F				[illegible]
6		1 H	1 F,M	1 G		1 F	1 O			
7		1 D			1 G	1 H	1 A	1 H		1 F,I
8	1 I	1 A				1 B	1 K	1 G		
9		1 K,L								
10			1 G							
11					1 F,H	1 B,H				1 M
12										
13										
15			1 K,O	1 C		1 B				
16				1 I	1 C					1 B,N,O
17			1 B,K				1 G,N			
18	1 L	2 B,C,L								1 G
19		1 K,N								
20				1 D		1 G				
22		1 N,O	1 B							
23										
24			1 C,O,I,L	1 J		1 B				1 B
25										1 A
26										
27						1 B,H				1 E,H,O
29										
30		1 B	1 B,I	1 O	1 B	1 K,N				
Dec. 1		1 E								1 B,I,N,O
2		1 B,H								1 F
3			1 D				1 I,O			
	2 Jobs	14	9	7	3	11	5	2	0	13

. . . continued to next page.

Akan Workshop

	Gearbox	Starter Motor	Front Suspension & Steering	Drive Shaft--U-Joints	Wheel Bearing	Differential	Engine Mounts	Engine Adjust.--Valve Adjust.	Engine Overhaul	Total Jobs by Day
Nov. 4								1 B,K		7
5	2 I,K L								1 D,H	10
6	3 F,I K,M						1 G		2 D,E K,O	11
7	1 H,K								2 E,F,G I,O	9
8	1 E								2 A,G I	8
9	1 G	1 K		1 H					1 G,I	5
10									1 G,I	2
11	1 H,K		1 F,L					1 E,K	3 E,K L,Q	9
12										0
13										0
15	1 Q									4
16									1 A,G	3
17								1 B,I	1 D,O	4
18										4
19					1 C,N					2
20								2 B,C I,Q	1 D,O	5
22										2
23									1 B,C	1
24								1 G,Q		5
25									1 A,B,Z I,N	2
26			1 D,E F,K							1
27										2
29										0
30									1 D,F	6
Dec. 1									1 E,K G	3
2									1 I,T N,O	3
3	1 B,I								1 B	4
	11	1	2	1	1	0	1	6	21	113 Total Jobs

Modern Motor Workshop	Oil Change	Maintenance-- Tightenint Nuts & Bolts	Brake Adjustment & Repair	Spark Plubs	Distributor & Contact Set	Carburetor	Radiator	Fuel Pump	Shock Absorbers	Clutch
Nov. 24										
25						1 R,T				2 R,S U
26										
27										
29										
30										
Dec 1		1 R,S U			1 R,S T,U	1 R,S T,U				
2			1							
3	1 S									
4										
5										
7										
8		1 R			1 R					
9			1 R,S T							
10			1 R,S T	1 R,S T						
11			1 R,S T							
13										
14										
15		1 R,S T,U	1 R,S T,U							
16		1 R	2 R,S T,U	1 R	1 R					
17		1 R,S T,U								
18				1 R,S T,U	1 R,S T,U	1 R,S T,U			1 R,S T,U	
19										
20			1 R,S T,U							1 R,S T,U
21			1 R,S T,U							
22		1	2 R,S T,U							
23										
	1 job	6	11	3	4	3	0	0	1	3

. . . continued to next page.

Modern Motor Workshop	Front Suspension and Steering	Gearbox	Water Pump	Drive Shaft--U-Joints	Wheel Bearings	Differential	Engine Mounts	Engine Adjust.--Valve Adjust.	Engine Overhaul	Total Jobs by Day
Nov 24										0
25										3
26										0
27										0
29		1 R,S T,U								1
30									1 R,S T,U	1
Dec 1		1 R,U						1 R,S T,U		5
2									1 R,S T,U	2
3	1 R,S T,U								1 R,S T,U	3
4	1 R,S T,U	1 R,S T,U								2
6									2 R,S T,U	2
7	1 R,S T								2 R,S T,U	3
8									1 R,S T,U	3
9	1 R,S T		1 R,S T							3
10										2
11										1
13										0
14										0
15										2
16	1 R,S T,U									6
17										1
18										4
19	1 R,S T,U									1
20										2
21										1
22										3
23		1 R,S T,U								1
	6	4	1	0	0	0	0	1	8	52 Total Jobs

APPENDIX G

TROUBLESHOOTING AN ENGINE FAULT

TROUBLESHOOTING AN ENGINE FAULT*

Symptom: Engine cranks normally but will not start.

Possible Fault	Confirmatory Test and Follow-up Measures	
1. Gas tank may be empty.	Check fuel gauge or gas tank to see if there is fuel in the tank. Is there fuel in the tank?	
	Yes	No
	Proceed to Step 2.	Put gas in the tank.
2. Engine may be flooded.	If there is a strong gasoline smell after cranking the engine, wait a few minutes before trying again to allow the fuel to evaporate. Does the flooding reoccur when trying to start it again?	
	Yes	No
	There may be trouble with the needle float valve in the carburetor. Proceed to Step 14.	If there was no flooding to begin with or if it does not reoccur proceed to Step 3.
3. Fault is likely to be either a fuel or an ignition problem.	Perform a rough and ready test to determine whether the fault is either a fuel or ignition problem. Remove the air cleaner. Manually operate the throttle linkage and check to see if fuel is coming into the air bore. Is fuel coming into the air bore?	
	Yes	No
	Fault is probably in the ignition system. Proceed to Step 4.	Fault is probably in the fuel delivery or carburetor systems. Proceed to Step 12.

Possible Fault	Confirmatory Test and Follow-up Measures	
4. The ignition system may not be producing an adequate spark for the spark plugs.	Disconnect high-tension lead coming from the coil at the distributor cap terminal. Hold end of wire close to engine block and check for a spark while cranking the engine. Is there a strong and regular spark from the lead over at least a 1/4" gap?	
	Yes	No
	The coil, breaker points and condenser are functioning normally. Proceed to Step 5.	Either the coil, condenser or breaker points may be faulty or else there is a break in the primary circuit between the distributor, coil and ignition switch. Proceed to Step 8.
5. The distributor cap or rotor may be leaking current and short-circuiting the spark plugs.	Remove distributor cap and look for any small cracks or carbon tracking. Check rotor metal contact plate and contacts on distributor cap for signs of wear. Are the distributor cap and rotor free from cracks, carbon tracking and excessive wear?	
	Yes	No
	Distributor cap and rotor are all right. Proceed to Step 6.	Replace any defective part(s).
6. The spark plug leads may be faulty.	Remove spark plug lead and hold end close to engine block. Check for a spark while cranking engine. Check each lead in succession. Is there a strong spark from all the leads?	
	Yes	No
	Plug leads are all right. Proceed to Step 7.	Replace any leads that do not produce a strong spark.

Possible Fault	Confirmatory Test and Follow-up Measures	Yes	No
7. The spark plugs may not be in good condition or be properly gapped.	Remove each spark plug and check its condition and its gap. Are all spark plugs in good condition and gapped correctly?	Spark plugs are all right. Proceed to Step 11.	Clean any plug with deposits and replace any cracked or defective plug. Note general condition of each plug and use information to find more obscure faults in Step 15 if necessary.
8. The breaker points may not be functioning properly.	Check gap and condition of breaker points. Is the gap incorrect or are the surfaces of the breaker points pitted?	Reset the gap and clean the points or replace them.	Breaker points are probably functioning normally. Proceed to Step 9.
9. The condenser may not be functioning properly.	Test the condenser by flicking open the breaker points with the ignition on. Note the size of the spark or whether there is a spark at all. Repeat the test after removing condenser lead from the distributor terminal. Does no spark in the first case become a fat spark in the second; or is there a fat spark in both cases?	Either the condenser is inoperative or is grounding out. Replace condenser.	The condenser is probably functioning normally. Proceed to Step 10.

Possible Fault	Confirmatory Test and Follow-up Measures	
10. The primary circuit may be broken or the primary side of the coil may be faulty.	Disconnect lead from the breaker points at the coil terminal and connect a wire at the terminal and ground it on the engine block with the ignition on. Check for a spark. Then remove the lead from the ignition switch at the coil terminal and ground that lead on the engine, again checking for a spark. Is there a spark across both of these gaps?	
	Yes	No
	Primary circuit and the primary side of the coil are in order. Proceed to Step 11.	If there is a spark from the ignition lead to ground but not one from the breaker point terminal to ground, the coil is faulty and should be replaced. If there is no spark from the ignition terminal, there is a break in the circuit from the battery. Check all wires leading from the battery to the coil.
11. The ignition timing may be off.	Check the static timing by lining up the marks on the engine pulley at T.D.C. of the compression stroke of cylinder number 1. Check the distributor to see that the rotor is pointed to the no. 1 post of the distributor cap and that the points are just opening. Is the rotor pointed to no. 1 post and are points just opening?	
	Yes	No
	Static timing is all right. Proceed to Step 12.	Reset rotor to correct position and adjust distributor until points just begin to open.

Possible Fault	Confirmatory Test and Follow-up Measures		
12. Fuel may not be reaching the carburetor.	Disconnect fuel line where it enters the carburetor, crank engine and check to see if fuel spurts out of the line. Does fuel spurt out of the line?	Yes The fuel delivery system is working normally and the fault may be in the carburetor. Proceed to Step 14.	No Either the fuel filter is clogged up, the fuel line is obstructed between the gas tank and carburetor, or the fuel pump is not functioning properly. Proceed to Step 13.
13. The fuel pump may not be functioning properly or the fuel filter may be clogged.	Disconnect the fuel line from the gas tank at the fuel pump connection. Put palm over fuel pump inlet, crank engine and see if there is any suction effect. Is there any suction?	Yes If there is gas in the tank, most likely the fuel filter between the pump and carburetor is clogged. Replace fuel filter.	No Fuel pump is probably faulty. Repair or replace it.
14. Dirt may be blocking the float needle valve, the jets or the fuel passages of the carburetor. Or dirt may be sticking the needle valve open, causing flooding.	If flooding occurs, tap carburetor near float chamber to try to dislodge any dirt causing the needle valve to be unseated. If fuel is not entering carburetor properly, disassemble carburetor and clean the needle valve and its seating, the jets and the fuel passages. Does car now start?	Yes	No The fault is probably the result of a more serious problem in the engine. Proceed to Step 15.

Possible Fault	Confirmatory Test and Follow-up Measures	
15. The engine may have such reduced compression that it cannot start or sustain operation.	Turn the fan blades by hand to note whether there is good compression. If available, apply a compression guage to all cylinders to check compression. Does there appear to be good compression in the cylinders?	
	Yes	No
	If compression is good and car still does not start, look for more obscure faults.	Perform detailed compression and vacuum tests (if test equipment is available) to determine specific nature of engine problem. If test equipment is not available, look for more obscure faults first before dismantling engine for overhaul.

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*Much of the technical data used in this flow-chart came from pages 80-89 in Odhams New Motor Manual, by Leonard Holmes (London: Hamlyn Publishing Group, 1976). The author also wishes to acknowledge the assistance of Mr. Edward Burke, a former professional mechanic, in organizing the flow-chart.

APPENDIX H

MECHANICS SKILLS TEST

WAYSIDE MECHANIC SKILLS TEST*

PART I

Level I Questions

Question #

1. - 10. Please tell me the size of spanner (wrench) that will correctly fit each of the nuts and bolts I will give you (give subject 10 nuts and bolts of various sizes to examine).

11. Given a bolt which is 1/2 inch across the head, what equivalent spanner would fit the bolt in Metric?

12. What liquid can be used to clean the spark plugs with?

13. What is a suitable grade of oil to use when changing the oil in a car in Ghana?

14. What liquid can be used in cleaning the valve seats after grinding them?

15. What is the best liquid to clean the valves and valve seats with?

16. Is it advisable to work under a car or lorry (truck) supported only by a jack? Why?

17. What is a "feeler gauge" and what is it used for?

18. What are the grades of valve grinding compound?

19. What should one disconnect first when beginning to remove the starter motor?

20. Can you use a 12 volt battery on a 6 volt car?

21. What tool is used to adjust the tie rods?

22. Is petrol (gasoline) an acceptable liquid to use in cleaning brake rubbers (seals)?

23. What is the best liquid to use in cleaning brake rubbers?

24. How can you tell when a valve has been grinded properly?

Level II Questions

25. What is an engine seat (mount)?

26. Why is it necessary to bleed the brakes?

27. Where are the contact breaker points found in a motor car?

28. Do diesel engines use spark plugs?

29. What is the bell housing?

30. Where are the kingpins located?

31. Where are the ball joints located?

32. Where is the timing chain found?

33. - 34. How many shafts are there in a three speed gearbox and what are they called?

35.- 37. Name the three parts that make up the clutch assembly.

38. The clutch assembly is usually attached to which part of the engine?

39. - 40. How many bearings are found in the hub assembly and what are they?

41. Where are the pinion and the crown wheel generally found?

42. What is the average spark plug clearance?

43. Where is the head gasket found?

44. Which side is number one cylinder generally found in relation to the engine compartment?

45. What is the use of the thermostat?

46. What is a gudgeon pin?

47. How is petrol transferred from the fuel tank to the carburator in a motor vehicle?

48. How is the fuel pump diaphragm operated?

49. What is one main reason for putting a pump in the cooling system of a motor vehicle?

50. How is the water pump driven?

51. - 58. What are the essential parts of the coil ignition system?

59. - 66. Examine this distributor carefully (give subject a distributor to examine). Please name the parts on it that I point to (point to, in order, the distributor cap, rotor, breaker points, cam, plate, flyweights, timing gear and vacuum advance).

69. - 70. What is the purpose of each of the following parts on the distributor (point to breaker points, cam, timing gear and vacuum advance)?

71. What is the meaning of the letters "A" and "R" on a distributor?

72. What is the purpose of the carburator?

73. What is the firing order of a normal four cylinder engine?

74. What is the firing order of a normal six cylinder engine?

75. If an engine has to be overhauled, what is the order in which the three major parts of the engine should be dismantled?

76. What is the purpose of the cylinder head gasket?

77. - 78. What is T.D.C. and what does it mean?

79. - 80. What kind of engine is this piston from (give subject a piston from a diesel engine to examine)? What is the reason for using a piston with a crown of this shape?

81. Why should the valves seat properly?

82. Why is it necessary to time the valves after an engine overhaul?

Level III Questions

83. What is one difference in the operation of a petrol engine and a diesel engine?

84. - 87. Give the movements of a piston, its inlet valve and exhaust valve during the time that the crankshaft of a four-stroke engine is turning two complete revolutions (use a piston to illustrate the reciprocating motion of the piston inside the engine).

88. - 92. Look at the spark plugs that I show you and tell me if the plug is suitable for use (show subject spark plugs or photographs of plugs representing five different conditions). Why or why not?

93. - 97. Tell me what the condition of the engine is on the basis of the condition of the plugs (again show subject the five plugs)?

PART II

1. Explain how the internal combustion or petrol engine operates. (If necessary, restate question as, "How does the engine get the power to make the car move?")

2. I am going to give you a problem to solve. Suppose an engine will not start although the battery is strong enough to make the engine crank. What are the possible faults that prevent the engine from starting? How would you go about finding what the actual fault is?

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*Many of the questions in this test were framed by Mr. John Mensah, a Ghanaian professional mechanic and a former dealer service manager. Additional questions were supplied by staff at the National Vocational Training Institute and culled from past City and Guilds Mechanics exams. Some of the answers used in scoring the test were composed by Mr. A. S. Kpodo of the Koforidua Technical Institute. The entire test and answer key were reviewed and refined by Mr. R. Hotobah-During, a consulting mechanical engineer in Ghana.

APPENDIX I

ANSWERS TO MECHANICS SKILLS TEST

ANSWER SHEET

WAYSIDE MECHANICS SKILLS TEST

PART I

1.	Spanner	#13	2.	Spanner	#14
3.	"	#13	4.	"	#18
5.	"	#10	6.	"	#10
7.	"	#17	8.	"	#18
9.	"	#24	10.	"	#19

11. #13 spanner

12. Petrol. Sandblasting is best.

13. S.A.E. 30 or 40. Or S.A.E. 50 for a car that burns oil.

14. Petrol (gasoline).

15. Kerosene is best.

16. No.

17. A tool used to measure small gaps or gauges such as contact breaker gaps, spark plugs gaps, and valve tappets.

18. Three. Rough grade, medium grade, and smooth grade. But answer of two is acceptable--rough and smooth.

19. The battery terminals.

20. No.

21. An open-end spanner.

22. No.

23. Metholated spirits (basically ether alcohol--such as Akpeteshie) is best.

24. When the valve forms a gas-tight seal when it is seated. One way to tell this is when some marks, which have been put on the edge of the valve at the beginning of grinding, are no longer visible.

25. The part on which the engine rests and is secured to the chassis.

26. To remove air.

27. In the distributor.

28. No.

29. The housing enclosing the clutch or the front part of the gearbox.

30. At the ends of the front axle.

31. At the ends of the suspension arms.

32. Usually at the front part of the engine attached to the crankshaft pulley gear and the camshaft gear.

33. Three shafts.

34. Clutch input shaft, output shaft, and layshaft. However, an answer of two is alright: mainshaft and layshaft.

35. Clutch disc or driven plate.

36. Pressure plate

37. Clutch release bearing.

38. The flywheel.

39. Two

40. The inner (big one) and the outer (small one) bearings.

41. In the differential.

42. 0.025 inches.

43. Between the cylinder head and the lower half block of the engine.

44. Generally facing frontwards towards the radiator.

45. To regulate the cooling system.

46. The pin that connects the piston crown to the connecting rod.

47. By a mechanical or electrical fuel pump.

48. By a cam on the camshaft; or on some cars by a cam off the crankshaft.

49. To speed up the circulation of water in the cooling system.

50. By a V-belt (or fan belt) off the crankshaft pulley.

51. The distributor cap.

52. Induction coil.

53. Spark plugs.

54. Condenser.

55. Contact breaker points.

56. Rotor.

57. High tension leads.

58. Ignition switch.

59. Distributor cap.

60. Rotor.

61. Contact set (or hammer).

62. Cam.

63. Plate.

64. Flyweights.

65. Timing gear.

66. Vacuum control.

Giving purpose of:

67. Contact set--to open and close the low tension electrical circuit at the appropriate point.

68. Cam--actuates the opening and closing the breaker points.

69. Timing gear (or driving gear)--drives the distributor and drives it in such a way that the rotor points to a segment in the cap when one piston is at T.D.C.

70. Vacuum control (or advance)--alters the relation between the contact breakers and the distributor cam to advance the spark at high engine r.p.m.

71. Advance and retard of the ignition mechanism.

72. To provide a correctly metered amount of fuel to the engine throughout the working range. Or to provide a vaporized, chemically correct mixture of petrol and air for the engine.

73. 1342 or 1243 for a 4 cylinder engine.

74. 153624 for a 6 cylinder engine.

75. a. cylinder head to be dismantled first. b. then the cylinder block to follow c. then the crankcase or oil pan.

76. To form a gas-tight joint between the cylinder head and the top of the engine block.

77. Top dead center.

78. It signifies when a piston is at the maximum or highest position of its stroke.

79. A diesel (compression-ignition) engine.

80. To serve as a combustion chamber and to get the maximum possible compression at the center of the piston.

81. In order to give a gas-tight seal during the compression stroke.

82. To enable the valves (inlet and exhaust) to open and close at the correct sequence relative to the movement of the piston.

83. Either of the following answers is correct for this question: During the induction stroke a mixture of petrol and air is drawn into the cylinder of spark-ignition engines, while only air in the compression ignition engine. During the power stroke, the compression mixture of petrol and air in the spark-ignition engine is ignited by an electric spark, while the high temperature of the compressed air ignites the sprayed fuel from the injectors in the compression-ignition engine.

84. First movement: piston moves down; inlet valve opens; exhaust valve closes.

85. Second movement: piston moves up; inlet valve closes; exhaust valve closes.

86. Third movement: piston moves down; inlet valve closes; exhaust valve closes.

87. Fourth movement: piston moves up; inlet valve closes; exhaust valve opens.

88. Condition #1--Sooted or Carbon-fouled. Plug has dull black carbon deposits.

89. Condition #2--Has cracked ceramic insulator. Plug cannot be used because it will certainly arc or cause misfiring.

90. Condition #3--Oil fouled. Plug cannot be used and should be replaced.

91. Condition #4--Normal condition. Plug can be used after cleaning.

92. Condition #5--Partially melted center electrode. Plug should be replaced with one of correct heat range.

93. Condition #1. Suggests over-rich carburetion--not enough air going to the cylinders. Also spark plug gaps may be too wide or the air filter very dirty.

94. Condition #2. Possibly caused by a flaw or by bad handling or engine overheating.

95. Condition #3. Carbon and oil deposits caused by too much oil in the combustion chamber. Indicates badly worn piston rings, cylinders, and valve guides.

96. Condition #4. Engine is running correctly.

97. Condition #5. Condition may be caused by ignition being advanced too far, by combustion deposits in cylinders, defective valves, defective distributor, bad fuel quality, or plugs with incorrect heat range.

PART II

1. There is no one correct answer to this question. But a correct answer should demonstrate a basic understanding of the engine as a device for utilizing the rapid expansion of combustible gas when it is being burned to forcibly move a movable object (i.e., a piston) in such a way that its reciprocating movement is converted into a rotary movement (by the crankshaft) which drives wheels to move the vehicle.

2. There is no one correct answer. The quality of the answer depends on the number of faults the apprentice can cite and whether or not he knows how to test for each of those faults. Every fault the

apprentice cites should first be listed. Then each possible fault should be taken in turn, asking him how he would determine if that fault was the one causing the problem. The diagnostic procedure outlined in Appendix G is one acceptable strategy for solving this starting problem.